A DICTIONARY

OF

SCIENCE, LITERATURE, AND ART.

VOL. I.

LONDON
PRINTED BY SPOTTISWOODE AND CO.
NEW-STREET SQUARE

A DICTIONARY

OF

SCIENCE, LITERATURE, & ART:

COMPRISING

THE DEFINITIONS AND
DERIVATIONS OF THE SCIENTIFIC TERMS IN
GENERAL USE, TOGETHER WITH THE HISTORY AND DESCRIPTIONS OF THE
SCIENTIFIC PRINCIPLES OF NEARLY EVERY BRANCH
OF HUMAN KNOWLEDGE.

EDITED BY

W. T. BRANDE, D.C.L. F.R.S.L. & E.

OF HER MAJESTY'S MINT

AND THE

REV. GEORGE W. COX, M.A.

LATE SCHOLAR OF TRINITY COLLEGE,
OXFORD.

IN THREE VOLUMES.

VOL. I.

LONDON:
LONGMANS, GREEN, AND CO.
1865.

~~Books of ref. Cam Kadel.~~
108 0 111

PREFACE.

THE DICTIONARY of SCIENCE, LITERATURE, and ART was designed to supply a want which could not be met by the larger Encyclopædias of modern times. Works of so vast an extent as the *Encyclopædia Britannica* or the *Encyclopédie Française* are too expensive for general circulation, while from their size they cannot well serve as manuals. On the other hand, Special Dictionaries, though they may exhaust some one branch of learning, are not intended to supply information on others; and thus a work like the present, possessing the comprehensive character of a general Encyclopædia without its amplitude, and affording in a convenient form an abstract of the principles of every branch of Science and an explanation of the various terms ordinarily met with in Literature and Art, still appeared to be wanting. The first edition of the present work was, therefore, offered to the public as a compendious Dictionary of a convenient size, adapted to the wants and means of all classes, and furnishing within comparatively narrow limits precise and accurate information on the all but infinite variety of subjects which it embraces. Great pains were taken to make the definitions clear, correct, and concise, and to insure a method of treatment which, though brief and compendious, should be neither flimsy nor superficial. No statement was made on doubtful matters without pointing out the source from which it had been derived; while the references given to the best works on all subjects of importance enabled the reader to extend his enquiries at will.

The first edition of this Dictionary was published twenty-four years ago. The period which has since elapsed has been marked by great progress in almost every department of human knowledge. The limits and relations of the Physical Sciences have been more

accurately determined, and the area of research in each has been greatly extended and more carefully scrutinised. The discovery of new objects has led to the invention of new names; while the accumulation of facts has in many cases modified or exploded theories which had gained general acceptance. Experience has justified the claims of Political Economy to the rank of a science; while the examination of the laws of evidence has strengthened, if it may not be rather regarded as having called into existence, the science of Historical Criticism. The analysis of Language has produced results of the utmost importance, not merely affecting the classification of dialects, but throwing light on many stages in the earliest developement and history of the human mind, and on many subjects of the highest interest connected with the legends and poems, the laws and society of pre-historic ages. With such changes as these, it was obviously impossible that any dictionary compiled more than twenty years ago could meet the wants or adequately represent the knowledge of the present day while any attempt to remedy the defect by mere corrections and supplements would probably render the book even less satisfactory to the general than to the scientific reader. To the latter the additional information given in a new edition might be technically useful, while his professional experience would have made him acquainted with the progress of knowledge in his own department. The more general reader would need to be informed not merely of new facts, but of the degree in which these facts have modified the character or tendency of each particular science. In a dictionary designed to give a clear but strictly succinct account of the principles of all sciences in a way which should be acceptable both to general readers and special students, this requirement could not be met except at the cost of re-editing and re-writing the work throughout. Thus re-written, the present edition is offered to the public as substantially a new work. As in previous editions, the several departments under which the subjects are arranged have been intrusted to writers who have devoted themselves to the special topics respectively assigned to them. The Editors believe, therefore, that the work may be consulted with confidence by all who wish to make themselves acquainted with the principles of each particular science, with the details and history of many, and with the main facts of the many subjects with which it

is necessary at the present day for all intelligent persons to have some acquaintance. In each case the first object of the writers has been to affirm positively none but duly ascertained facts, to leave open all doubtful questions, and to reject statements for which a more stringent research has failed to produce adequate evidence, even though these statements may have for many the force and charm of old associations.

A few words will suffice to indicate the changes which have been made, on these principles, in the present edition.

In the Biological Sciences, the rapid progress of Comparative Anatomy since 1842, especially in its morphological aspects, has rendered necessary the introduction of a large number of new words; and it is hoped that all such words in current use will be found in this portion of the Dictionary. On the other hand, many words have been excluded which, although occasionally employed, lack that stamp of authority which alone can justify their insertion in a standard dictionary. In Zoology, the recent discoveries of interesting generic forms of life have been described in new articles; whilst the improvements which have taken place in classification have led to a careful revision of the systematic arrangement employed in the last edition. But only those classifications have been accepted which are in general use, in preference to others (possibly more accurate, but at present more hypothetical) which may be adopted at some future time. In Palæontology, a large number of new articles have been required to describe the more important fossil forms with which the progress of the science has made us acquainted.

In Geology, it has been thought that the purposes of the Dictionary would be better answered by presenting the subject under the several branches into which the science is divided. While, therefore, the general article in this department has been greatly curtailed, this loss of matter is more than compensated by new articles, to which the reader is carefully referred in the general article, and which, it is hoped, will put him in possession of all the conclusions which in the judgment of the best geologists may be considered trustworthy on the important subjects which have of late years furnished matter for geological discussion, especially on questions relating to changes of the earth's surface and climate, and to the antiquity of the human race.

The introduction of Physical Geography is practically a new feature in the present edition. Although an attempt to impart to this work the character of a Geographical Dictionary would obviously be out of place, it was felt that an important branch of knowledge would not be fairly represented without giving some account of the principal features of the globe, its oceans, marine currents, and continents, its mountain chains, lakes, and inland seas, and the general action of volcanic forces.

In Astronomy, the application of photography to the production of permanent records of celestial phenomena, the improvements in astronomical instruments, and the wonderful discoveries made through spectrum analysis, have all been concisely but carefully described, and an attempt has been made to render this Dictionary a useful companion to the Telescope, by recording especially the results of recent observations.

In Chemistry and Physics, also, a thorough revision of articles had become necessary; and the new matter added contains, it is hoped, a notice of all the most important advances even in sciences of such vast extent. In Mineralogy, large additions have been made to the number of terms, although it is not pretended that an exhaustive list has been given of technical names, many of which would rarely, if ever, be met with except by strictly scientific readers.

The great progress made during the last generation in the oldest of all sciences, Mathematics, has rendered a slight alteration of arrangement advisable. The expositions of the more permanent portions, which are fully treated in standard text-books, have been curtailed in the present edition; while an attempt has been made, for the first time, to collect and render intelligible the many terms which have been introduced into modern Geometry and Algebra, so far as the limits of this work would permit. More advanced readers will find copious references to the best sources of information in each branch of the science.

The recent applications of science to Agriculture have been carefully treated in the articles relating to this subject; while the systems of Botanical classification have been examined by the light which the growth of the science has thrown on their correctness or inaccuracy.

The general subject of Architecture has been kept distinct from

the special details of Building and Engineering. Under the latter, the inventions and improvements of the present century have, it is hoped, been fully described. Under the former, mere theories and conjectures have been excluded from what is designed to serve as a philosophical account of the developement of all styles of Architecture.

The Military articles have been subjected to a strict revision. These articles in the last edition were, and indeed could not fail to be, behind the standard of the present day. Great pains have been bestowed to correct all mistakes which may have been made through inadvertence or want of knowledge, as well as to give the latest information on all Military and Naval subjects of general interest. With this view, all words have been inserted which are likely to be met with by any except advanced professional students of the art. The changes effected by the introduction of iron armour-plates and rifled arms have been fully described, and the most important points connected with the effects of shot from rifled guns are noticed under the head of PROJECTILE.

For the articles in Political Economy which appeared in former editions, we are indebted to Mr. M'Culloch, whose ability and merits are gratefully acknowledged. But it cannot be doubted that, if his life had been spared, he would have felt it necessary to modify many statements on subjects which of late years have undergone a more thorough discussion. On this account, as well as in order to give the results of recent experience, all the articles belonging to the science have been thoroughly revised, and in great part re-written, while many new articles have been added on subjects connected with labour and capital, and other topics which of late years have assumed more or less importance.

The Theological articles are strictly confined to a statement of facts and doctrines, or of arguments in support of or against the latter, as urged by either side, without any controversial remarks on the subjects to which they relate.

In the Historical articles many changes have been rendered necessary by the increasing attention paid to the laws of evidence, and to the critical tests which distinguish oral tradition from authentic contemporary narratives. These tests have been, it is hoped, impartially applied in all those articles which treat of periods for which no really historical evidence exists, and of which many must be set

aside as belonging to that region of Mythology on which the progress of Philological Science has recently thrown great light. Indeed, the science of Comparative Mythology may almost be said to have come into existence since the first edition of this work was published. As a necessary consequence, almost every article on matters connected with Mythology, Epic Poetry, and the legends of what are known as the Heroic Ages, has been wholly re-written, while new subjects have been introduced so far as they were needed in order to give an adequate account of the present state of the science.

On the subject of Derivations or Etymology, the Editors wish to leave no room for misunderstanding. Their first object has been to give the nearest form in which any word occurs in cognate languages to which it is most closely related. Hence in cases where the English term is, letter for letter, the same with a foreign word, all that has been done is to name the language in which that word is found. But it is not meant that the mention of a word in a parallel language, such as Dutch, Swedish, or German, implies the borrowing of the word from the one to the other, or even that where a word is found in English, Latin, Greek, and Sanscrit, any ground is furnished for the conclusion that the English has received the word from the ancient languages, or that any one of the latter borrowed it from the rest. The task of tracing words to their original source is one of which it is perhaps impossible to exaggerate the importance; but it belongs wholly to the professed philologist, and can be at best but briefly treated in the present work under the head of LANGUAGE. Hence, with but very few exceptions, no attempt has been made to give the history of the changes of words. The English *age* is referred to the French *âge*; but it is not the province of ageneral Dictionary like the present to trace the word back through the Old French édage, and the Latin ætaticum, ætas, ævitas, ævum, to the Greek *αἰών*. In such instances, however, references have been given to philological works, by the aid of which the reader may if he wishes carry his researches further. Nor must it be assumed that words given as derivations are in all or in most cases words used in what are called the best classical periods. Terms of doubtful origin are marked as such, any further explanation being withheld unless a derivation may be proposed with some plausibility. Not unfrequently a derivation is given from the works of recent philologists, whose names are appended. Such derivations

are given on the responsibility of the author, and not necessarily as being considered in themselves satisfactory or conclusive. It appeared only fair, however, that in doubtful cases such writers should at least be allowed a hearing. In the case of scientific terms, whose hybrid character in many instances is admitted on all hands, nothing more has been attempted than to give the words out of which (sometimes contrary to all rule or analogy) they have been coined or compounded.

In the number of scientific terms explained in this work, a very large increase will be found in the present as compared with the last edition. It would indeed have been impossible within the limits of this Dictionary to include all the terms employed in any branch of science; but it is believed that a sufficient number has been introduced to meet the requirements of all general readers and non-professional students. The increase of matter which this greater fullness of treatment has entailed, together with the adoption of a more legible type, has made it necessary to extend the size of the work to three volumes.

Lastly, the Editors express their hope, that no omissions may be found of any matter of real importance contained in the last edition, and that in general accuracy and fullness of information the present work may adequately exhibit the results of the scientific research and general knowledge of the present day.

W. T. Brande.
G. W. Cox.

DICTIONARY

OF

SCIENCE, LITERATURE, AND ART.

A. The first letter of the Alphabet, in all known languages, with the exception of the Amharic, the modern dialect of Abyssinia, in which it is the thirteenth, and of the Runic, in which it is the tenth. It was called *Alpha* by the Greeks, and *Aleph* by the Hebrews.

A, in Heraldry, is the dexter chief or chief point in an escutcheon.

A had an arithmetical value amongst the Greeks and Romans: its value with the former was 1, and with the latter 500, or with a line over it 5000.

A, in Logic, is the sign employed to denote a universal affirmative proposition. [Logic.]

A, *a*, or *aa*, in Medical prescriptions, is used for ana, *in equal parts*.

A. The name of one of the notes in music, corresponding to the French *La*.

A.A.A., in old Chemistry, means an amalgam.

Aardvark (Dut. *earth-hog*). The *Orycteropus capensis*, an insectivorous animal remarkable for the facility with which it burrows in the earth. It is more closely related to the armadillos than to the ant-eaters.

Abaca (the *Anisa textilis*). A kind of palm tree growing abundantly in the Philippine Islands. Of the fibres of this tree a cordage is made which has the property, like that of coir, of floating in water. The sea water does not rot it, and it therefore requires no tarring. A portion of the fibre, which is white and fine, is manufactured into excellent linen and other valuable textures.

Abacinare (Ital. *to dazzle*). A punishment of the middle ages, in which the criminal was blinded by holding red-hot irons before his eyes.

Abaciscus. In Architecture, any flat member. The square compartment of a mosaic pavement. [Abacus.]

Aback. In sea language, denotes the position of the sails when laid flat against the mast by the force of the wind. This may happen either by a sudden change of the wind, or an alteration of the ship's course; or the sails may be *laid aback* for the purpose of avoiding some imminent danger.

Abacot. A cap of state worn by the old English kings. It was made in the shape of a double crown.

Abacus (Lat.). In Architecture, the upper, or top, moulding of the capital of a column, so called from its supposed resemblance to a table (ἄβαξ). It serves to form a wide bed for the architrave of the entablature immediately above it.

Abacus. An ancient instrument used for facilitating numerical calculations. The name is of doubtful origin. The instrument consists essentially of a parallelogram divided by parallel bars, on which small pebbles or counters are placed. The counters on the lowest bar denote units, those on the second tens, those on the third hundreds, and so on; one counter on a superior bar being equal to ten on the bar immediately below it. By means of nine counters for each bar, it is obvious that any number may be thus expressed. It will be observed that the artificial value given to the counters, according to the positions which they occupy, is entirely analogous to our numerical system of digits. The form of the instrument admitted of considerable variety. The Grecian abacus was an oblong frame, having wires stretched across it, strung with perforated beads or little ivory balls. In the Roman abacus the counters were slid along grooves. The Chinese, like the Greeks, employ wires with beads; and with them the abacus or Swan-pan is in universal use, as it conveniently adapts itself to their decimal divisions of weights and measures. The abacus continued to be used in European countries during the middle ages. Instead of a board, however, with bars or wires, it became the practice to cover a bench or *bank* with chequered cloth, on which the counters were disposed. Hence our terms exchequer, bankrupt, &c. For an excellent account of the abacus, and of palpable arithmetic generally, see the

article on arithmetic, in the *Encyclopædia Britannica*.

Abaft, or **Aft.** In sea language, denotes nearness to the stern or hinder part of the vessel. Thus a thing is abaft the foremast when it is between the foremast and the stern.

Abaissed (Fr. abaisser, *to lap down*). In Heraldry, a term applied to the wings of eagles, when closed, or with the tips looking down to the point of the shield.

Abandonment. A term used in marine insurances, where, before compensation can be demanded, the insurer must abandon his interest in any portion of the rescued property. It is also used, in the language of the customs, to signify the abandonment of an article by the importer to avoid payment of the duty.

Abatement, Plea of. In Law, is pleaded to a declaration, writ, &c., on account of some defect in form. [PLEADING.]

ABATEMENT. In Heraldry, symbols of disgrace introduced into arms: mentioned for the most part only by English heraldic writers. A *delf*, or *quadrant spot*, is the sign of a revoked challenge: an *escutcheon reversed* belongs to an ungallant person or deserter: a *point dexter parted*, to a boaster: a *point in point*, to a coward: a *point champain*, to one who kills a prisoner of war: a *gore sinister*, to effeminate persons: a *gusset dexter* denotes voluptuousness, a *gusset sinister* intoxication. The only abatement now used in practice is the *baston*, which belongs to bastards; it is in the form of the bend sinister, contains one-fourth of the dimensions of the escutcheon, but does not reach quite to its circumference.

Abater, or **Abator.** In Law, one who puts an end to a nuisance, or who enters a house or land vacant by the death of the former possessor, and not yet taken possession of by his heir or devisee.

Abatis (Fr.). A term of military engineering applied to a species of fence placed in front of a breastwork or on a glacis, for the purpose of impeding the advance of an attacking party. Generally speaking, an abatis is composed of trees cut down, and laid with their branches pointing towards the enemy, so as to offer resistance to the troops attempting to scale the works, by rendering it necessary to use both hands to clear a way through the boughs, whilst the defenders are at full liberty to use their weapons.

Abaton (Gr. *inaccessible*). An edifice at Rhodes, built by Artemisia to commemorate her conquest of the island. It afterwards received the name of Abaton, because the Rhodians, on regaining their liberty, made it inaccessible.—*Vitruvius*, ii. 8.

Abattoir (Fr. from abattre, *to knock down*). A large public slaughter-house, under the direct control and management of the municipality of a town, for the express purpose of insuring the killing and preparation of animal food under the conditions most favourable for the health of the population consuming it. The abattoirs of Paris, commenced under Napoleon I. in 1810, and finished by the Bourbons in 1818, are even at the present day the best models of this class of municipal constructions. A full description of them is to be found in La Bruyère's *Études sur l'Art des Constructions*; Grantham's *Description of the Abattoirs of Paris*; and in one of the detached essays of the Architectural Society, published in 1849.

Abb, or **Abb-wool.** Names given by clothiers to the yarn of a weaver's warp.

Abbassides. The name of a family of Arab caliphs, who reigned from 749 to 1257. The name is derived from Abbas ben Abd-al-Motalleb, a paternal uncle of the prophet Mohammed. The most celebrated of the Abbassides was the wealthy, luxurious, and splendid caliph Haroun al Raschid, whose reign is regarded by Mohammedans as the golden age of their dominion.

Abbess (Fr. *abbesse*). The governess or superior of a monastery or abbey for females. By a decree of the Council of Trent she must be of the age of forty years, and have professed eight years at least.

Abbey (Fr. *abbaye*). In Architecture, the conventual buildings of a monastery, including the church. In Ecclesiastical History, an abbey is a monastery governed by an abbot, under whom is a prior. The abbeys had the highest rank among religious houses, and enjoyed some superior privileges.

Abbot (Heb. abba, *father*). The superior of a monastery for men. Monastic societies, being originally composed of laymen, were obliged to have recourse to the assistance of a neighbouring priest to administer the sacraments and perform other clerical functions among them. Afterwards the superior of the society in many cases entered into orders, and exercised the ministerial office for the convenience of his community, under the title of abbot. From the beginning of the sixth century this practice became universal, the abbot having absolute power within his own monastery, but being himself subject to the authority of his diocesan. This subjection, however, the abbots gradually threw off to a great extent, and in many places themselves assumed the titles and authority of bishops. Such were the mitred abbots, and the crosiered abbots; the former of whom, to the number of twenty-six, sat in the English parliament with the bishops and two priors in the reign of Henry VIII.

Abbots are properly superior in rank to priors; the latter being often appointed by the abbot to superintend a dependent foundation. But the distinction does not appear to have been regularly observed, and there are certain orders whose superiors are always called priors; as the monks of Vallombrosa, the Cistercians, Bernardists, Feuillants, Trappists, Grandmontanists, and Præmonstratenses. After the sixteenth century, besides the regular 'abbots,' there grew up in France a class styled 'abbots commendatory,' who were candidates for some priory or abbey in the gift of the crown, and

under engagements (not often fulfilled) to enter into orders within a year. They wore the 'petit collet' as the symbol of their devotion to the church; and of this class were the 'abbés,' so well known in literary and fashionable life.

Abbot of Misrule. In ancient times, was the master of the revels, called in Scotland the 'Master of Unreason.'

Abbreviatio Placitorum (Lat.). In Legal History, an abstract of ancient pleadings made prior to the year-books.

Abbreviation (Lat. brevis, *short*). In Arithmetic. The process by which a fraction is reduced to lower terms; thus the division of the numerator and denominator of $\frac{16}{24}$ by 8 reduces or abbreviates the fraction to $\frac{2}{3}$.

ABBREVIATION. In Music, a stroke which, placed over or under a note, divides it into quavers if there be only one; if two, into semiquavers; if three, into demisemiquavers.

ABBREVIATION. In Writing, before the invention of printing, a variety of abbreviations were used, most of which have gradually fallen into disuse: they generally consisted in substituting the initials for the words. Of the abbreviations at present in use, the following are those which most commonly occur.

In Titles:—

A.B. or B.A., Bachelor of Arts
A.M. or M.A., Master of Arts
S.C.L., Student in Civil Law
B.C.L., Bachelor of Civil Law
D.C.L., Doctor of Civil Law
B.D., Bachelor of Divinity
D.D., Doctor of Divinity
Clk., Clerk or Clergyman
M.D., Doctor of Medicine
F.R.S., Fellow of the Royal Society
C.B., Companion of the Bath
G.C.B., Grand Cross of the Bath
G.C.H., Grand Cross of Hanover
K.B., Knight of the Bath
K.C.B., Knight Commander of the Bath
K.C.H., Knight Commander of Hanover
K.G., Knight of the Garter
LL.D., Doctor of Laws
M.P., Member of Parliament
M.R.I.A., Member of the Royal Irish Academy
Mus.D., Doctor of Music
Ph.D., Doctor of Philosophy
Q.C., Queen's Counsel
R.A., Royal Academy
R.A., Royal Artillery
R.E., Royal Engineers
R.M., Royal Marines
R.N., Royal Navy
S.T.P., Sanctæ Theologiæ Professor
W.S., Writer to the Signet

Miscellaneous, Diplomatical, &c.:—

A.D., the year of our Lord
A.H., the year of the Hegira
A.M., the year of the world
i.e., that is to say
ib., in the same place
id., the same
N.B., for nota bene, observe
viz., for videlicet, to wit
L.S., (in a deed) the place of the seal
R.S. and L.S., right and left side
N.S., new style (since 1752)
O.S., old style (before 1752, and in the Greek calendar)
A.C. or B.C., the year before Christ
A.U.C., the year from the building of Rome
Nem. con., no one contradicting
Nem. dis., no one dissenting
MS., manuscript
A.M., morning
P.M., afternoon
H.M.S., Her Majesty's ship or service
D.G., by the grace of God
F.D., Defender of the Faith
H.R.E., Holy Roman Empire
U.S., United States of America

Abbreviators (Lat. abbreviator, from abbrevio, *I shorten*). Officers of the papal court who assist the chancellor in drawing up briefs and petitions with a view to their conversion into bulls.

Abdication (Lat. abdicatio, from abdico, *I abdicate*). In Politics, the renunciation of an office or dignity by its holder; but it is commonly meant to express the voluntary renunciation of supreme power. The most famous examples of this on record are the abdication of the dictatorship by Sylla, 75 B.C.; of the imperial throne, by Diocletian, A.D. 305; of the emperor Charles V., in 1556; and of Christina, queen of Sweden, in 1654. The Convention Parliament of 1688 used the word abdication to express the act of James II. in abandoning the government and kingdom. The word 'desertion' was rejected, as implying the possibility of a return. The Scottish Convention of Estates declared that James had 'forfeited' the kingdom. Abdication is said to differ from resignation, the former being unconditional, the latter done in favour of some other person.

Abditorium (Low Latin). In Archæology, a secret place for hiding or concealing valuables.

Abdomen (Lat.). The great cavity of the animal body, which is liable to temporary changes in its dimensions, independently of respiration. In Entomology it forms, in insects the third, in arachnidans the second, in both classes the most posterior, of the sections into which the body is externally divided, and contains the principal digestive and respiratory, and the whole of the generative organs. The enlargement of the abdomen, in relation to the activity of the generative functions, is most remarkable in insects; in some of which, as the white ant, or termite, it constitutes, at the full developement of the ova, an immense proportion of the entire body of the female. In vertebrata the abdomen is not divided externally from the thorax; and only in one class, the mammalia, by an internal partition, or diaphragm. In vertebrata the abdomen is beneath the neural axis, and always on the ventral side of the body, from which the limbs are developed. In articulata it is above the neural axis, which occupies the ventral or under side of the animal.

The abdomen is the first-formed cavity in the developement of the animal body, and is the most constant in its existence throughout the animal series. [CRANIUM and THORAX.]

Abdominals. An order of Malacopterygious fishes, including those which have the ventral fins situated under the abdomen, behind the pectorals. [MALACOPTERI.]

Abduction (Lat. abductio, from abduco, *I lead away*). In Law, the forcible carrying away of a woman, for the purpose of marriage or defilement. Where the female has property, or is presumptively entitled to it, such abduction is felony: and in all cases the taking of a girl under sixteen from under the protection of her parents is a misdemeanour. The crime of abduction, according to Sir Walter Scott (see his Notes and Introduction to *Rob Roy*), was at one period extremely common on the border of the Scottish Highlands.

Abduction. In Logic, a form of argument, answering to the Greek ἀπαγωγή, wherein the greater extreme is obviously contained in the middle, but the middle not so evidently in the less extreme as not to require some further proof to make it appear.

Abductor. Abductor muscles are those which pull back or separate the limbs to which they are affixed.

Abelian Equation. The eminent mathematician Abel having shown that the solution of an irreducible algebraic equation [Irreducible Equation], one of whose roots is expressible as a rational function of a second, can always be effected by the solution of a second equation of lower degree, modern algebraists sometimes distinguish equations possessing the property in question by the term *Abelian*.

Abelian Integrals. A term applied to a certain class of ultra-elliptic integrals, whose properties were first investigated by Abel. The term *Abelian function* is usually restricted to inverse Abelian integrals, which are analogous to functions of the amplitude of an ordinary elliptic integral, as also to inverse circular and logarithmic functions, such as, $\sin.^{-1}x$, $\log.^{-1}x$, &c. For further particulars the reader is referred to the memoirs of Abel, Jacobi, Richelot, Weierstrass, and others in *Crelle's Journal*.

Abelites, or **Abelians.** In Ecclesiastical History, a sect mentioned by St. Augustine, in Africa. They are said to have enjoined marriage and virginity, after the pretended example of Abel.

Abelmoschus (Arab. Kabb-el-misk, *musk-seed*). A tropical genus of the Mallow family, one species of which, *A. moschatus*, otherwise *Hibiscus Abelmoschus*, produces seeds which have a strong musky odour, and have been used in perfumery, and also medicinally. Another species, *A. esculentus*, is the ochro or gobbo of the West Indies, where its pods, on account of their nutritive mucilaginous qualities, are much used in thickening soups.

Aber. A Celtic term, implying the mouth of a river; as Aberdeen, the mouth of the Dee; Aberystwith, the mouth of the Ystwith, &c.

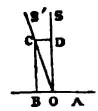
Aberdevine, or European Siskin (*Carduelis spinus* Cuv.). A small green and yellow finch, belonging to the same subgenus as the goldfinch of this country.

Aberrant. In Botany, where certain species or groups differ materially from their types.

Aberration (Lat. aberratio). A term used in Astronomy, to denote a change in the apparent positions of the celestial bodies arising from the combined effects of the motion of light and the motion of the earth in its orbit.

To explain the cause of this remarkable phenomenon, conceive a ray of light to proceed from a star S to an observer at O. If the station of the observer were at rest, or if the motion of light were instantaneous, the star would be seen in its true place at S. But neither of these circumstances can take place;

the observer is carried rapidly forward by the motion of the earth in its orbit, and light occupies a certain time in coming from any of the heavenly bodies to the earth. Suppose, then, that while a wave of light advances from D to O, the observer has been carried forward by the earth's orbital motion from A to O. At O the wave will strike the eye with a velocity proportional to D O, and the eye will impinge against the wave with a velocity proportional to A O.



The two simultaneous impressions which the eye at O thus receives may obviously be represented in magnitude and direction by the lines D O and B O, equal to A O, and the effect is the same as if the eye had received a single impression from a wave of light advancing along the diagonal C O of the parallelogram B O D C. The apparent place of the star therefore will be at S', in advance of its true place at S.

The angle C O D, or the *aberration*, is obviously zero when the directions O B, O S, coincide, and it acquires its greatest value when these directions are perpendicular to each other. In the latter case it is called the *constant of aberration*, and expressed in circular measure (this angle being small) by the ratio

$$\frac{\text{velocity of the earth}}{\text{velocity of light}}$$

From Bradley's observation the Constant of Aberration was determined by Bessel (*Fundamenta Astronomiæ*) to be 20'·25. Dr. Brinkley found it = 20"·37. Mr. Richardson, from a series of 2,000 observations made with the two mural circles in the Greenwich Observatory, found the value of this important element = 20"·307. (*Memoirs Royal Ast. Soc.* vol. iv.)

The effect of aberration on a star situated in the plane of the ecliptic is an apparent annual oscillation in a straight line extending to 20"·3 on each side of its true position. A star situated in the pole of the ecliptic appears, from the same cause, to describe a circle around its true position as centre, and having a radius of 20"·3. In any other position the apparent path of a fixed star is an ellipse whose major axis is 40"·6 and minor axis 40"·6, multiplied by the sine of the star's latitude.

The apparent places of the planets are also affected by aberration; but in this case, as the body from which the light emanates is also in motion, we must consider that the ray of light which enters the eye, and to which the correction for aberration must be applied, has proceeded, not from the place which the planet occupies at the instant of the observation, but from that which it occupied at as long an interval previously as light requires to traverse the distance between the planet and the earth.

The aberration was discovered, and its physical cause first explained, by Dr. Bradley. It is the most direct proof which astronomy furnishes of the motion of the earth round the sun.

ABERRATION. In Optics, denotes the deviation of the rays of light from the true focus of a curved lens or speculum; in consequence of which they do not unite in a single point, but are spread over on a small surface, and form a somewhat confused image of the object. This arises from two causes: 1st, the figures of the lenses or specula; and 2ndly, from a difference in the physical nature of the rays of light.

The surfaces of the lenses or mirrors of optical instruments are generally worked into a spherical form, on account of the difficulty of accurately obtaining the parabolic curvature which theory shows to be necessary to collect parallel rays into a single point or focus. Hence the rays meet the axis of the lens or mirror at different points, the amount of deviation depending on the magnitude and curvature of the lens. This is called the *Aberration of Sphericity*. The second cause of aberration, which occurs only in lenses, arises from the different degrees of refraction which the rays composing a beam of light undergo in passing from one medium into another. On account of this difference of refrangibility, the rays of light are separated, and the colours of the spectrum appear. It was long believed, and even by Newton himself, that it was impossible to refract without decomposing light; and hence the attempts that have been made to perfect reflecting telescopes, and adapt them to the purposes of accurate observation. But it has since been discovered that the refractive and dispersive powers of different transparent substances are in different proportions, and that the decomposition of the light may be prevented by combining substances of different refractive powers, for example, crown and flint glass, in the same lens. [ACHROMATISM.]

Abettor (Sax. abedan, *to incite*). In Law, an instigator or inciter; a person who promotes or procures the commission of an offence or felony, by his advice or encouragement. If an abettor, or, as he is then termed, an aider and abettor, be present at the commission of the crime, he is treated as a principal; if absent, he becomes an *accessory* before the fact. But in almost all cases of felony the abettor is considered as much a principal as the actual felon, especially in the case of murder, and the abettors of offences punishable summarily by justices of the peace are subject to the same penalties as the principals.

Abeyance (Norm. Fr. beyer, *to expect*). In Law, the fee-simple, or inheritance of lands, is said to be in abeyance, when there is no person in esse in whom it can vest and abide, although limited and ready to vest whenever the proper heir appears. Thus, in a grant to A for life, and afterwards to the heirs of B, the inheritance remains in abeyance until the death of B, as there can be no heir to a living person. A peerage descending to co-heiresses is said to be in abeyance.

Abib (Heb. *a green ear*). The first month of the Hebrew year, more generally known by the Chaldean name of *Nisan*. It is first mentioned in Exodus xiii. 4.

Abichite. A name for native arseniate of copper, after Prof. H. Abich. [CLINOCLASE.]

Abies (Lat. *a fir tree*). The name of all those fir trees which, like the Spruce, the Larch, and the Cedar of Lebanon, have their leaves growing singly upon the stem, and the scales of the cones round and thin. The wood called by timber-merchants 'white deal' is produced by *Abies excelsa*; and a resinous or terebinthaceous substance by others: as Canadian balsam by *A. balsamea*; Strasburgh turpentine by *A. pectinata*, the silver fir; Venetian turpentine by *A. Larix*, the larch. Besides these, the substance called extract of spruce is furnished partly by *A. canadensis*, and partly by *A. nigra*. All the species are hardy, and, with the exception of larches, are evergreen, and in cultivation in this country. The most valuable for the timber are, *A. Douglasii*, *A. excelsa*, and *A. Larix*; the most ornamental are, *A. Cedrus*, the Cedar of Lebanon, *A. Deodara*, and *A. Larix*; the most worthless in Great Britain are, *A. canadensis*, *A. picea*, *A. balsamea*, and *A. pectinata*: the three latter form, however, fine trees in favourable situations. The wood of the fir is in very extensive use, and it is, perhaps, the most serviceable of all trees.

Abietinae. A division in the natural order of Coniferous plants, comprehending the true firs and pines, and the araucaria-like pines, all which have cones with many rows of scales in which the seeds are formed.

Abietine. A resin contained in crude turpentine.

Abjuration, *Oath of* (Lat. abjuratio). Introduced by stat. 13 W. III., and regulated by 6 G. III. An oath asserting the title of the present royal family to the crown of England, and abjuring allegiance to that of the Pretender. A single oath is substituted for this and the oath of allegiance and supremacy by 21 & 22 Vict. c. 48.

ABJURATION *of the Realm*. In Law, signifies a sworn banishment; or the taking of an oath to renounce and depart from the realm for ever.

ABJURATION also signifies a solemn recantation of opinion: as, the abjuration of heresy required by the Romish Church. Henry IV. abjured Protestantism at Saint-Denis in 1593. Galileo was compelled to abjure his philosophical opinions by the Inquisition at Rome, in 1633.

Ablactation (Lat. ablactatio, from ablacto, *I wean*). A method of ingrafting trees. When the new stock is ingrafted with the old one and then cut away, it is *weaned* from the tree.

Ablative Case. The name given to the sixth case of Latin nouns, its chief use being *instrumental*. [GRAMMAR.]

Ablution (Lat. ablutio, *washing*). A religious ceremony, consisting in bathing the body, or part of it. It constituted a part of the Mosaic ceremonial, and was afterwards practised among the Jews, both by the priests and people. Ablutions are most rigidly enforced by the Mohammedans.

Abnormal (Lat. ab, *from*, and norma, *a rule*). Anything without, or contrary to, system or rule. Thus Horace calls a self-taught person—

abnormis sapiens, crassâque Minervâ.

In Botany, if a flower has five petals, the rule is that it should have the same number of stamens, or some regular multiple of that number; if it has either four or six stamens, then, in such a case, the flower would be abnormal.

Abolitionists. In Politics, a name usually applied to the partisans of the abolition of slavery in the United States. It came into common use after the foundation of the 'American Anti-Slavery Society' by Garrison and others at Boston, in 1852.

Abomasus. The fourth stomach of ruminants, in which the process of digestion is completed.

Aborigines. The first, or original (*ab origine*), inhabitants of a country, that is, those who occupied it at the period when it began to be known, and who either were indigenous to the soil or had immigrated thither before the dawn of history. Some of the ancients supposed they had always inhabited the same soil, and were created from it, as the Athenians, who thence called themselves *autochthones*, i.e. sprung from the land. But the Romans and modern nations use the word Aborigines to designate those inhabitants of a country of whose origin nothing certain is known. Thus the Indians of America are properly called aborigines, because they were found there at its discovery, and we have no accounts of their having immigrated from any other quarter. (Sir G. C. Lewis, *On the Credibility of Early Roman History*, ch. viii. sect. 2; Ihne, *Researches into the Roman Constitution*, p. 39.)

Abortion (Lat. abortio, *miscarriage*). This term is usually applied to the morbid or unnatural expulsion of the fœtus in the human subject after the sixth week, and before the sixth month, of pregnancy. Before the sixth week it is called a *miscarriage*, and after the sixth month, *premature labour*. The 24 & 25 Vict. c. 100 deals with the crime of procuring miscarriage.

ABORTION. In Botany, the suppression, or absence, or non-developement of an organ, the existence of which is either assumed by analogy, or detected by accidental conditions of the same plants.

Abortive. In Botany, is said of parts in plants that do not acquire their usual state of perfection. A flower only partially formed, a stamen whose filament has no anther, a seed which contains no embryo, or which consists only of skin, are cases of abortion. The term is also applied to parts which, although perfect in the beginning, cease to grow, and so end in being imperfect; thus ovules, which are not impregnated, and which shrivel up instead of growing into seed, are called abortive.

Abouhannes. An African bird, supposed to be the Ibis of the ancients.

Abracadabra. A celebrated term of incantation: especially used as a spell against fevers. The manner in which it was written and carried for that purpose may be seen in Defoe's *History of the Plague*. The word seems to be connected with *Abrasax* or *Abraxas*, a name inscribed on certain stones or amulets, together with the figure of a human body with the head of a cat and feet of a reptile. Various explanations have been attempted of the object of these curiosities: some from cabalistic and Egyptian derivations. Bellermann (Berlin, 1817) and Neander have written on the subject of the Abraxas stones.

Abramis (*Abramis* Cuv.). The name of a subgenus of Malacopterygious or soft-finned abdominal fishes, characterised by the absence of spines and barbels; by the dorsal fin being short and placed behind the ventrals, and the anal fin being long. The common bream is a species of this genus.

Abranchians (*Abranchia* Cuv.; Gr. ἀ, priv., βράγχια, *gills*). An order (the third in Cuvier's arrangement) of Anellidans, so called because the species composing it have no external organs of respiration; they are divided into the setigerous abranchians, or worms (*Anellida terricola*), and the non-setigerous abranchians, or leeches (*A. suctoria*).

Abrasion (Lat. abrado, *I rub off*). In Numismatology, implies the waste of coins, or their loss by wear and tear. This forms a considerable item in the expense of a metallic currency; and various means have been employed to lessen it, by alloying the coins so as to render them harder, by raising the borders so as to lessen the surface exposed to be rubbed, &c.

Abraxas. A genus of Lepidopterous insects, of the family *Geometridæ*; founded by Dr. Leach for the common magpie moth (*Abraxas grossulariata*) and other allied species. It is the larvæ of the *A. grossulariata* which commit the well-known ravages upon the gooseberry trees of our gardens, consuming the leaves almost as soon as they appear. They feed early in the morning, before the dew is off or the sun has much power: and it is at this time that they should be sought for and removed.

ABRAXAS, or ABRASAX. In Ecclesiastical History, a mystical term for the supreme God. The word in Greek letters represents 365, the number of the deities supposed by the Basilidians to be dependent under the All-ruling One.

Abrazite (Gr. ἀ, neg., and βράζω, *I bubble*; because it does not effervesce before the blowpipe). A Mineralogical synonym for Gismondine.

Abridgement (Fr. abréger, *to shorten*). In Literature, a compendious arrangement of the matter contained in a larger work. Before the invention of printing, when manuscripts were valuable, and the labour of writing them great, the abridgement of considerable works was an important branch of authorship. Among the best known abridgements of antiquity are the *History of Justin*, an abridgement

of the lost *History of Trogus Pompeius*, the *Natural History of Solinus*, chiefly abridged from that of *Pliny*, &c. Few modern abridgements, taking the term in its strict sense, merit peculiar notice, or have been compiled with any other view than that of assisting education. This, however, is not the case with some works, called abridgements, which are intended to exhibit a summary view of some science or department of literature. The *Abrégé Chronologique de l'Histoire de France*, by the president Henault, is a work of this kind. Its success led to the publication of other abridgements of the same kind, of which the *Abrégé Chronologique de l'Histoire de l'Allemagne*, by Pfeffel, is probably the best.

Abridgment. In Law, a declaration or count made shorter by subtracting or severing some of the substance therefrom; e.g. a man is said to abridge his plaint in assize, and a woman her demand in action of dower, where any land is put into the plaint or demand which is not in the tenure of the defendant. (Wharton's *Law Lex.*)

Abrogation (Lat. abrogatio). The annulment of a law by competent authority. A phrase derived from the practice of the Roman popular assemblies, in which the several tribes, curiæ, &c., were said rogare suffragia, *to demand the suffrage*: whence also the modern word *prerogative*. [Comitia.]

Abrotanum (Gr. ἀβρότονον). An old name of the bitter aromatic southernwood, *Artemisia Abrotanum* of botanists. It is Abrotonum in Latin.

Abrupt (Lat. abrumpo, *I break off*). A term in Botany, applied to anything which suddenly comes to an end. A leaf which is suddenly terminated without tapering to a point, a stem which is suddenly bent, a pinnated leaf without a terminal leaflet, are all abrupt.

Abrupt. In Ichthyology, is applied to the lateral line when divided into two or more parts not contiguous.

Abrus (Gr. ἁβρός, *delicate*, or *elegant*). A West Indian tree with papilionaceous flowers, and pods containing bright red seeds with a broad black scar on one side of them. The seeds are often strung into necklaces for children.

Abscess (Lat. abscedo, *I depart*). Inflammation in the membranous or fleshy parts of the body, attended by the formation of *pus*, and the consequent separation or distension of the parts affected; thus the integuments separate from the parts beneath, and form a tumour.

Absciss, or **Abscissa** (Lat. abscindo, *I cut off*). A term used in Geometry to denote a segment cut off from a straight line by an ordinate to a curve. [Co-ordinates.]

Absentee. In Politics, a word which has received a peculiar signification, denoting a landed proprietor who habitually resides at a distance from the district in which his property is situated. It is especially applied to Irish landlords and clergy. In 1715 a tax was imposed on absentees from Ireland, in all cases where their residence within it was for less than six months in the year; power of dispensation being secured to the crown. But it ceased to be levied in 1753, and has not since been renewed. Whether the absence of a landed proprietor be injurious to a country, in an economical sense, is a question which has been much debated of late years. The contrary opinion has been strongly advocated by Mr. M'Culloch before the committees of the Lords and Commons on the state of Ireland, 1825 and 1830, and in *Essays*, &c. 2nd ed. 1859: see also *Quarterly Review*, vol. xxxiii., and Mr. Senior's *Outline of Political Economy, Encyclopædia Metropolitana.*

Absinthine (Gr. ἀψίνθιον). A peculiar bitter principle extracted from wormwood, *Artemisia Absinthium.*

Absinthium. The common bitter wormwood, called *Artemisia Absinthium* by botanists.

Absis, Apsis, or **Apse** (Gr. ἁψίς, *an arch*). In Ecclesiastical Architecture, a term used to express the end of the choir of a church, whether its form in plan be that of a semicircle, of a polygon, or even of a rectangle. Properly speaking, the word should be applied only to the vaulted extremity of the ancient basilicas; but by extension it is made to express not only the end of the choir of a church, but also the series of small lateral chapels usually arranged behind the altar end. In the early Christian churches, the bishop's throne was placed in the apsis behind the altar, and upon the axis of the church; but in later periods, the throne was placed at the end of the rectangular part of the choir, while the chapel of the Virgin was placed upon the continuation of the centre line of the apsis. Generally speaking, the crypts, or vaults, were placed under the apsis, so as to insure their being under the altar; and for this reason the apsis was at first constructively, and subsequently traditionally, raised above the level of the floor of the rest of the edifice. In the early Christian churches the apsis, separated from the choir by an open railing, was exclusively reserved for the officiating priests; but in mediæval churches, this special distinction is not retained, whilst the choir itself is separated from the nave by the rood screen or *jubé*. Occasionally the ends of the transepts also are finished with vaults, and are said to have apsidal ends.

The apsidal form, as representing the round church in which the sacred mysteries were at first celebrated, has been retained throughout in the churches of France and Germany. In Italy it has been employed chiefly in baptisteries: in England it is reproduced in the circular chapter-houses, while the square end has been generally substituted in churches. (Fergusson, *Handbook of Architecture*, p. 619.)

Absolute Curvature. [Curvature.]

Absolution (Lat. absolutio). In Theology, a declaration of forgiveness of sin. The nature of sacerdotal absolution in the Church of Rome is defined in the Canons of the Council

of Trent. The Church of England has three forms of absolution: (1) in the Daily Service, which is merely declaratory; (2) in the Office of Communion; (3) in the Visitation of the Sick. (Hook, *Church Dictionary.*)

Absorbed (Lat. absorbeo, *I suck up*). In Painting, sucked up, imbibed. A term applied by the French connoisseurs to a picture in which the oil has sunk into the canvas or ground whereon it is painted, leaving the colour flat, and the touches indistinct. Our picture-dealers use the term *chilled* to express the same thing.

Absorbent Ground. In Painting, a ground prepared for a picture, either on board or canvas, chiefly with distemper or water-colour mixture, by which expedient the oil is immediately taken or sucked in, and a brilliancy imparted to the colours.

Absorbents. In Medicine, substances which remove acid at the stomach, such as magnesia and chalk.

Absorbing Well. A shaft, or well, sunk through an impermeable upper stratum to a permeable lower one, capable of carrying away the liquids thrown into it at a higher level than the permanent water line of the lower stratum. The dead wells, as they are called at Southampton, and in the south of England, are absorbing wells in gravel formations with close steined work at the top, and dry steining in the lower parts, and without paved floors, through which the liquids may infiltrate the surrounding ground. In France, the establishment of absorbing wells is regarded with great jealousy, and it is necessary to obtain the consent of the municipal authorities before commencing any such work: there is no legislation on the subject in England.

Absorption. In Physiology, is one of the vital organic functions, the object of which is primarily to convey to the circulating organs the due supply of the materials for the growth and support of the system; and, secondarily, to remove and carry from the same organs the decayed and useless parts of the body. [LACTEALS and ASSIMILATION.]

Abstinence (Lat. abstineo, *I abstain*). In the Roman Catholic church, the refraining from the use of certain kinds of food on particular days, but only from the prohibited kinds. In this respect it differs from fasting.

Abstract. In Architecture, or in Engineering, the term 'abstract' is usually employed as a substantive, to express that portion of the bill of quantities, estimate, or account, which contains the summary of the various detailed articles; and it is upon this abstract that the prices are applied. In works upon Æsthetics, the term is used, both substantively and adjectively, to express the general and universal conditions affecting the subject under consideration, without reference to the adventitious circumstances by which it may be surrounded, or to the nature or influence of the details upon its external expression.

Abstract Mathematics, or **Pure Mathematics.** That branch of science which treats of the relations or properties of magnitudes or quantities, considered generally, and without restriction to any individual magnitude. Thus, the proposition that the three angles of a triangle are together equal to two right angles, is an abstract truth, applying equally to all triangles whatsoever. *Abstract Mathematics* is opposed to *Mixed Mathematics*, wherein abstract properties or relations are applied to sensible objects. [MATHEMATICS.]

Abstract, or **Pure Numbers.** Numbers considered in themselves, and without reference to the particular things enumerated. The operations of common arithmetic are performed on abstract numbers.

Abstraction (Lat. abstractio, from abstraho, *I draw off*). In Metaphysics and Logic, the faculty by which, in contemplating any object, we can attend exclusively to some circumstances or qualities belonging to it, and withhold our attention from the rest. It is by the means of this faculty that we generalise, and arrive at the common terms or predicables [PREDICABLES] which belong to a number of objects. Thus, in considering a horse, by abstracting mentally the qualities which belong to that particular animal, we arrive at the notion of a quadruped, thence at that of an animal, &c. &c.; which notions constitute, in logical language, the successive genera and species of the individual horse.

Absurdum, or **Reductio ad Absurdum.** A term used in Geometry to denote a mode of demonstration in which the truth of a proposition is established, not by a direct proof, but by proving that the contrary is *absurd*, or impossible. There are many examples of this mode of demonstration in the Elements of Euclid.

Abundant Number. In Arithmetic, is a number such that the sum of its divisors is greater than the number itself. Thus, 12 is an abundant number, because its divisors being 1, 2, 3, 4, and 6, their sum, which is 16, is greater than 12. An abundant number is opposed to a *deficient* number, of which the sum of the divisors is less than the number itself; and to a *perfect* number, of which the sum of the divisors is equal to itself.

Abutment (according to some, from the Fr. aboutir, *to abut*). In Architecture, the term *abutment* signifies the solid part of the structure against which the ultimate dynamical effort of an arch is exerted: of late years, however, it has been more especially applied to the resisting point of a series of arches, whilst the term *springing* has been more particularly applied to the abutment of single arches. In long bridges, viaducts, and aqueducts, the abutments are usually understood to mean the solid structures at the respective ends; the springings of the so-called 'land arches.'

Abyss (Gr. ἄβυσσος). In Heraldry, denotes the centre of an escutcheon.

Acacia (Gr. ἀκακία). A genus of spiny leguminous trees, with pinnated leaves, and

small flowers collected in balls or spikes of a white, red, or yellow colour. They are all inhabitants of the warmer parts of the world; some of them, as *A. vera*, *A. arabica*, &c., yield gum arabic; others gum senegal: the bark of *A. Catechu* furnishes the astringent substance called catechu or terra japonica. The flowers of *A. Farnesiana* are exceedingly fragrant, and form one of the principal ingredients in Italian perfumery. The bark of many species abounds in tanning principles. New Holland and some other countries produce multitudes of species in which true leaves are not formed, but in their stead the branches are furnished with broad dilated petioles looking like leaves; these are called phyllodes.

Academics. A name given to a series of philosophers, who taught in the Athenian Academy, the scene of Plato's discourses. They are commonly divided into three sects, which go under the names of the Old, the Middle, and the New Academy. 1. The Old Academy, of which Plato was the immediate founder, was represented successively by Speusippus, Xenocrates, and Polemo. These philosophers, as far as the scanty notices remaining of them allow us to form a judgment, seem to have confined themselves to the task of elucidating and defending the doctrines of their great master. [PLATONISM.] A list of their works is given by Diogenes Laertius, b. iv. To them succeeded Arcesilaus, the founder of (2) the Middle Academy. Under his hands, the Platonic method assumes an almost exclusively polemical character. Whatever may have been his belief regarding the positive part of Plato's doctrines, he confined himself in public to the support of the negative portion; that, namely, which relates to the uncertainty of the impressions on the senses, and, consequently, of the judgments founded on them. His main object was to refute the Stoics, who maintained a doctrine of perception identical with that promulgated by Dr. Reid in the last century. [PERCEPTION.] Socrates is said to have professed, that all he knew was, that he knew nothing. Arcesilaus denied that he knew even this. Wisdom he made to consist in absolute suspension of assent; virtue, in the probable estimate of consequences; in the latter doctrine combating the ethical dogmatism of the Stoics, as in the former the intellectual. He was succeeded by Lacydes, Telecles and Evander, and Hegesinus. 3. The New Academy claims Carneades as its founder. It is not easy to define the limits between this and the Middle Academy. Like Arcesilaus, Carneades appears to have taken up a negative position. His system is a species of mitigated scepticism. He considers probability to be the sole legitimate object, alike in speculation and in practice. The doctrines of this school were adopted by Cicero, more, probably, in consequence of the advantage which, as an orator, he would derive from the practice of discussing both sides of a question, than from any solid conviction. Carneades was succeeded by his disciple, Clitomachus. Charmides, the third and last of the New Academicians, appears to have been little more than a teacher of rhetoric: an accusation, indeed, to which the whole school is in no small degree liable. To these three academies, a fourth and fifth are added by some writers: of which Philon and Antiochus are produced as the representatives. The latter was the friend of Cicero and other distinguished Romans. Neither of them can in any justice be named academics, their doctrines being in fact, in most points, of a diametrically opposite nature.

Academy (Gr. ἀκαδημία). A society of learned men, associated for the advancement of the arts or sciences. The name is derived from that of a place near Athens, where there was a famous school for gymnastic exercises [GYMNASIUM], at which also philosophy was taught, and the sophists gave their lectures. But the first institution of which we read, at all resembling our modern academy, was the Society of Scholars, established at Alexandria by Ptolemy Soter. The Jews in various cities, the Constantinopolitan emperors, and the Arab caliphs, founded societies of the same description. Charlemagne, among his various efforts for the propagation of literature, collected an association of learned men, who read and compared the works of antiquity, and gave themselves, in their academic intercourse, the assumed names of different ancient authors. But this institution was dissolved at the death of Alcuin; nor do we find any memorial of a similar society, except a few among artists, chiefly in France, until after the taking of Constantinople by the Turks, when the Greek scholars driven into Italy held literary meetings, which gradually assumed a more regular form. About 1560 a society, called the Academia Secretorum Naturæ, was founded at Naples, in the house of Baptista Porta, but was abolished by a papal interdict. It was, however, succeeded by the Academia Lyncei at Rome, of which Galileo was a member, the objects of which, like those of the former, were chiefly connected with the pursuit of natural history. From the beginning of the seventeenth century academies multiplied in Italy. Among the most eminent of those which bore a philosophical character, was the A. del Cimento, at Rome, in that century; and, in more recent times, the Academy of Sciences at Bologna deserves to be mentioned with honour. But Italy has been most prolific in academies of literature and philology, which form by far the greatest number in the catalogue of 550 such institutions which have been enumerated as existing or having existed in that country. A general and somewhat ridiculous fashion prevailed in the seventeenth and eighteenth centuries among literary men of that country, of forming themselves into societies for the promotion of literary objects, to which they gave fanciful symbolic names, every member assuming in his own person some analogous appellation. Some of these societies have done real service to literature,

but by far the greatest number have contented themselves with multiplying insipid addresses and sonnets. Among the most celebrated was the A. degli Arcadi, at Rome, of which the meetings were held in a meadow, and the members enacted shepherds and shepherdesses: it was founded about 1690, and still subsists, having various affiliated societies in other places. The A. degli Umidi, one of the oldest of these associations, became afterwards the Florentine Academy. The A. degli Intronati (of the Deaf), degli Umoristi (of the Humorists), and many others with similar quaint appellations, have acquired celebrity in Italy. Of her philological academies, the most illustrious is that della Crusca (of the Sieve), at Florence, which, by the publication of its dictionary, established the Tuscan dialect as the standard of the national language; it is now incorporated with the A. Florentina. In France, the Académie Française was founded in 1635 by Cardinal Richelieu. It was an association formed for the purpose of refining the French language and style; and, although in its first period it was chiefly remarkable for the adulation which it bestowed on its vain though able founder, it became, in process of time, by far the most celebrated and influential of all European literary societies. It consisted of forty members, and a place among them was eagerly sought after, for a long period, as one of the highest honours which could be attained by an author. Like that of la Crusca, it published a Dictionary of the French language, in 1694. The Royal Academy of Sciences was founded by Louis XIV. in 1666, and published 130 volumes of memoirs, up to the year 1793, when it was abolished by the Convention. The Academies of Painting and Sculpture, and that of Inscriptions and Belles Lettres, were the other two principal academies of Paris. The latter was founded by Colbert in 1663, and remodelled in 1701. At the Revolution all four were abolished; and, in 1795, at the suggestion of Condorcet, the National Institute of France was established in their stead. It consisted of four classes, arising out of the four academies of which it was composed. According to its reorganisation by Napoleon, in 1806, these classes were remodelled, and each of them consisted of a certain number of sections, each furnished with a specified number of acting and corresponding members. The first class, or that of sciences, had sixty-three members, and 100 correspondents; that of languages, forty, and sixty correspondents; that of history and antiquities, forty, and sixty correspondents; that of the arts, twenty-eight, and thirty-six correspondents. The first, third, and fourth, each named eight foreign associates. In 1816, the Institute was again remodelled by Louis XVIII. The four classes again took the name of academies, and became more independent of each other, their joint property being managed by a commission of eight members, two from each, under the superintendence of the minister of the interior. The first academy (that of sciences) retained the same number of members. The second and third were reduced to thirty-eight and thirty-seven respectively; the fourth, increased to forty. To the Academy of Inscriptions and Belles Lettres, and that of Sciences, was added a class of free academicians, of the number of ten, with no privilege except that of attendance; the Academy of Arts had the right to choose its own number of free members.

Of similar institutions in Germany, the oldest was the Academia Naturæ Curiosorum, a scientific association, founded in 1652, in Franconia; afterwards taken under imperial protection, when it received the name of the A. Cæsareo Leopoldina. The Royal A. of Sciences, at Berlin, was founded in 1700 by Frederick I. of Prussia: Leibnitz was its first director. The Imperial A. of Sciences at St. Petersburgh was founded by Catharine I., and endowed by Catharine II. with great munificence, but established on the French model: she separated from it the A. of Arts.

In England (of public institutions), the name academy has been chiefly confined to associations for promoting the arts. The Royal Academy of Arts was founded in 1768, and consists of forty members; it has separate professors of painting, architecture, anatomy, and perspective; and a council of nine is elected annually. In this year (1863), a Royal Commission has proposed considerable changes in its constitution. The A. of Ancient Music was founded by private association in 1710: the Royal Academy of Music, under the patronage of George III., but dissolved shortly after. Our principal literary and philosophical societies, answering in character to the branches of the French Institute, are:—1. The Royal Society of London, which is confined to objects of a scientific character. It had its origin as early as 1645, but was established by royal charter in 1662. Its acts have been published, under the name of *Philosophical Transactions*, from 1665 to the present day. 2. Those of the Antiquarian Society, which was established in 1751, are published under the title of *Archæologia*. 3. The Society of Arts originated in 1718. 4. That of Literature in 1823. Besides these, there are numerous societies which bear the name of the peculiar branch of science to which their exertions are confined. The Royal Society of Edinburgh obtained a charter in 1783, and another, with more liberal provisions, in 1811. Among the most valuable published transactions of academies and similar societies, besides those already mentioned, are those of Colbert's A. des Inscriptions et Belles Lettres (fifty vols. 4to, from 1701 to 1793): those of the Institute, being continuations of the memoirs of the former academies of which it was composed: those of the A. Royale des Sciences et Belles Lettres at Berlin; at first in Latin, then in French (from its remodelling in 1744 by Frederick the Great), now in German. The 'Acta' of the Imperial Academy of St. Petersburg. The 'Commentarii' of the A. of Bologna. The 'Antichita

d'Ercolano,' published by the Herculanean Academy of Naples.

Academy Figure. In Painting, a drawing usually made with black and white or tinted chalks, on plain or tinted paper, after the living model. Oil-studies from the Life School, in the Academy, are also called Academy Figures. Such studies by Mulready and Etty are now highly valued as works of art.

Acadialite, or **Acadiolite.** A variety of Chabazite, probably containing an admixture of quartz. The colour (wine-yellow, or flesh-red passing into white) is arranged in a tesselated manner in some crystals, the angles being nearly colourless. The term Acadialite is derived from *Acadia*, a former name of Nova Scotia, where the mineral is found.

Acajou. The French name for mahogany; also a name sometimes applied to the Cashew nut, *Anacardium occidentale.*

Acalephans, Acalephæ (Gr. ἀκαλήφη, *a nettle*). A class of radiate invertebrate animals, so called on account of the singular property possessed by most of the species therein comprehended, of irritating and inflaming the skin when touched. The class includes the animals called 'medusæ,' 'sea-nettles,' 'jelly-fish,' 'Portuguese men-of-war,' &c.: these are divided by Cuvier into those which have air-bladders for swimming, or the 'hydrostatic acalephans,' and those which have not, or the 'simple acalephans,' and which swim by means of external cilia, or by the contractions and dilatations of their gelatinous body. All the species are marine. Some of them contain as much as 99 per cent. of water, and may therefore almost be described as 'living water.'

Acamptosomes (Gr. ἀ, neg., κάμπτω, *I bend*, and σῶμα, *the body*). An order of cirripeds including all those in which the body is entirely enveloped in a calcareous compound shell, and so attached that it cannot be unfolded and protruded.

Acanthaceæ. [ACANTHUS.] A natural order of monopetalous exogenous plants, in which the genus *Acanthus* is stationed. They have irregular didynamous flowers, and are particularly known by their calyx being imbricated in two broken whorls, and by their seed growing from hooks on the placenta. Many of this order have beautiful flowers, others are mere weeds. They are found wild only in hot or temperate climates.

Acanthia. [ACANTHUS.] The name of a genus of hemipterous insects of the tribe *Geocorisæ*, characterised by a long and straight rostrum, sheathed at its base, or through its entire length; labrum very prominent; eyes of large size; and the head presenting, at its junction with the thorax, neither a neck nor a sudden constriction. In some of the species (subgenus *Syrtis*), the anterior pair of legs terminate in a monodactyle chela, or forceps claw, like that of the crustacea, adapted for seizing a living prey.

Acanthocephalans, Acanthocephala (Gr. ἄκανθα, *a thorn*, and κεφαλή, *a head*, *spiny-headed*). An order of intestinal worms, or entozoons, which attach themselves to the mucous coat of the intestines by means of a proboscis surrounded with minute recurved spines.

Acanthoide (Gr. ἄκανθα, *a spine*). A mineral apparently related to Breislackite. It occurs in dark brown fibres passing into reddish-brown, disseminated in lava; and in very slender and silky, whitish needles, in a Vesuvian lava erupted in 1821.

Acanthophis (Gr. ἄκανθα, *spine*, and ὄφις, *serpent*). A genus of venomous serpents, allied to the viper, peculiar to Australia, and characterised by a horny spine, simulating a sting, at the end of the tail.

Acanthopods, Acanthopoda (Gr. ἄκανθα, and πούς, *a foot*, *spine-footed*). This name is applied to a tribe of clavicorn coleopterous insects, including those species which have spiny legs.

Acanthopteri (Gr. ἄκανθα, *spine*, and πτέρυξ, *a fin*). An order of fishes characterised by possessing the endoskeleton ossified; fins with one or more of the first rays unjointed or inflexible spines; ventrals in most beneath or in advance of the pectorals; swim-bladder without air-duct. It is divided into two suborders, CTENOIDEI and CYCLOIDEI [each of which see]. Cuvier's first order of fishes, *Acanthopterygii*, was characterised by the bony spines which form the first rays of their dorsal and anal fins, and generally, also, the first ray of the two ventral fins.

Acanthurus (Gr. ἄκανθα, *a spine*, and οὐρά, *a tail*). A genus of spiny-finned fishes, characterised by trenchant and serrate teeth, and by having a strong moveable spine, sharp as a lancet, on each side of the tail, by means of which these fishes have the power of inflicting very severe wounds.

Acanthus (Gr. ἄκανθος). A spiny herbaceous plant with pinnatifid leaves, and large whitish flowers enveloped in spiny bracts, found in various parts of the Levant.

ACANTHUS. Used in ornament, its leaf is the chief decoration of the Corinthian capital, so called from the tradition that it was first so applied by Callimachus of Corinth, about 400 B.C. It is also the chief foliation of Roman scroll-work; but there is a difference between the Greek and Roman leaf: the former uses the *Acanthus spinosus*, or prickly acanthus; the latter the *Acanthus mollis*, the brank-ursine of our islands. (Wornum, *Analysis of Ornament*, &c.)

Acardia. A term applied to a genus of fossil ostracean bivalves, in which the hinge (cardo) is wanting, and the flat valve is applied to the convex valve, like a lid to a vessel; the two having been connected only by the adductor muscle.

Acari (Gr. *a mite*). In Entomology, the term is restricted to the tracheary arachnidans which have either a single-jointed chelicer, or pincer representing an antenna, or a suctorious mouth. All the species are extremely minute or even microscopic, as the cheese-mite (*Acarus*

domesticus), and many of them parasitic; of the latter, the itch-insect (*Sarcoptes scabiei*) is a remarkable example. The mites are active insects, and possess great powers of life, resisting for a time the application of hot water, and of alcohol.

Acaulis (Gr. ἄκαυλος). Literally stemless, but applied to plants when the stem is very short, and not apparent.

Acaulose (Gr. ἀ, priv., and καυλός, *a stem*). In Botany, a term used for those plants which have no stem.

Accapitum. In feudal times, money paid by a vassal on his admission to a feud.

Accedas ad Curiam (Lat. *that you go to the court*). In Law, the title of a writ which removes a plaint from an inferior court, generally the county court, the issuing of which is a preliminary to trying a question of right upon a distress of goods by the proceeding called Replevin.

Acceleration (Lat. acceleratio, *a hastening*). In Mechanics, the increase which takes place in the velocity of a moving body. The acceleration is said to be *uniform* or *variable*, according as in equal intervals of time, however great or small, the increase of velocity is the same or different.

The first law of uniformly accelerated motion at once follows from this definition; it is expressed by saying that *the velocity is proportional to the time* which has elapsed since the motion commenced. The second law, according to which *the space described is proportional to the square of the time*, is a simple consequence of the first. For this space is obviously the same as that which would be described by a second body moving for an equal period with an invariable velocity equal to half that which the first body finally acquires. Now this space is proportional not only to the time, but also to the velocity; which latter, by the first law, is itself proportional to the time; the space in question therefore is proportional to the square of the time.

From these laws it follows, too, that in uniformly accelerated motion, *the velocity is proportional to the square root of the space* described from the position of rest.

Uniformly accelerated motion is the result of the incessant action of a force of constant intensity. In fact, the action of such a force may be conceived to consist of equal impulses imparted at equal and very small intervals of time. Since, therefore, by Newton's first law, a body is incapable of altering its own state of rest or motion, the aggregate effect of such impulses, in other words, the acceleration, must be proportional to their number, that is to say, to the number of intervals of time which have elapsed, or, more simply, to the time itself as stated in the definition.

The most familiar, if not most perfect, example of uniformly accelerated velocity is presented by the fall of bodies in consequence of the earth's attraction, which latter force varies inappreciably at the distances accessible to us. Accordingly the above two laws, after making allowances for errors of observation, resistance of the air, &c., have been verified by experiment. [Gravity and Gravitation.] All that has been said of uniformly accelerated motion applies of course (*mutatis mutandis*) to uniformly retarded motion, an example of which is presented whenever a body is projected vertically from the earth's surface. The height to which such a body will rise will obviously be the same as that through which it must descend in order to acquire a velocity equal to the one with which it was projected.

Acceleration of the Fixed Stars. The apparent greater diurnal motion of the fixed stars than of the sun; in consequence of which they daily come to the meridian of any place at an earlier hour of the solar day than they did on the day preceding. Thus, a star which to-day passes the meridian at six o'clock, mean time, will pass the meridian to-morrow three minutes and fifty-six seconds before six o'clock, the difference in time being equal to that between the lengths of a solar and sidereal day. [Day, Sidereal.]

Acceleration of the Moon. An increase of the mean angular velocity of the moon about the earth; in consequence of which, the time of her mean periodic revolution is somewhat shorter than it was many centuries ago. This acceleration is exceedingly small, amounting only to about ten or eleven seconds of a degree in a century. It was discovered by Dr. Halley from a comparison of very ancient with modern observations, and was confirmed by an examination of the observations of the Arabians in the 9th and 10th centuries. Its physical cause long occasioned great perplexity to mathematicians, and was at length detected by Laplace. It depends on a very slow secular diminution of the eccentricity of the earth's orbit. One of the greatest discoveries in physical astronomy is, that all variations in the elements of the planetary system are periodic. Some centuries after the present time, the eccentricity of the earth's orbit will arrive at its minimum value, and then begin to increase. When this period arrives, the mean motion of the moon, which for many centuries has been accelerated, will begin to be retarded. [Perturbation.]

Acceleration of the Planets. The motion of a planet in its orbit is variable, being quicker or slower, according as the planet is at a less or a greater distance from the sun. Hence, in moving from the apogee to the perigee of the orbit, the motion of a planet is accelerated; and, on the contrary, in moving from the perigee to the apogee, the motion is retarded.

Accent (Lat. accentus). In ordinary language, the greater or less stress laid in pronouncing on each syllable of a word is termed the accent of that syllable. But the accent of a Greek syllable is a species of tone, respecting which very contradictory notions prevail among modern commentators, and of

which it is indeed difficult to form any accurate conception. The history of the employment of accentual marks in writing the Greek language is extremely obscure. They are found in manuscripts of considerable antiquity. In our pronunciation of Greek, they are wholly neglected. But the modern Greeks pronounce their language, in general, laying the stress on the accented syllables, and neglecting the quantity. The mark of the acute accent is ´; of the grave `; of the circumflex, which is a compound of the other two, ˆ or ˜. But every syllable which has no accentual mark is said to have the grave accent; the grave being only marked on final syllables of words which have no acute accent on any syllable. These three accentual marks are also employed in the French language; but in it they are only employed, for convenience, to mark a difference in the pronunciation, not in the accent; the modifications of the vowel sounds not being all of them expressed by distinct letters.

ACCENT. In Music, a certain stress or forced expression laid on certain parts of a bar or measure. The first note of a bar has the strongest accent, but subordinate or weaker accents are also laid on the first notes of any subordinate divisions of the bar. For example, in a bar of eight quavers, the first has a strong accent, the third, fifth, and seventh weaker accents. In a bar of nine quavers, the first has a strong accent, the fourth and seventh weaker ones. Sometimes an abnormal accent is laid on what would otherwise be a weak note. This is called *emphasis*, and its skilful use is a great beauty in composition.

Accentor. A genus of seed and insect-eating passerine birds, of which the hedge-chanter, or, as it is commonly called, the hedge-sparrow (*Accentor modularis*), is a well-known example.

Acceptance. [BILL OF EXCHANGE.]

Acceptor (Lat.) [BILL OF EXCHANGE.]

Accessary or **Accessory** (Fr. accessoire). In English Law, an accessary to an offence is one who is not the chief actor, or present at its performance, but is concerned therein, either before or after the fact. An accessary before the fact is one 'who, being absent at the time of the crime committed, doth yet procure, counsel, or command another to commit a crime.' An accessary after the fact is one who, knowing that a felony has been committed by another, receives, relieves, comforts, or assists the felon. The law of accessaries and abettors is now regulated by 24 & 25 Vict. c. 14. [LAW, CRIMINAL.]

ACCESSARY. In Painting and the Fine Arts, is a term which extends to everything introduced into a work that is not absolutely necessary, or only illustrative. In an historical picture, for instance, the figures which are in action are the principal objects; by them the story is told; all the rest are accessories. Especial care is to be taken that they be so selected and disposed as not to interfere with the principal group; hence the ancient painters and sculptors were very shy of using them, lest the eye should be drawn away from the principal group, and its interest be thus lessened or destroyed. Objects or landscapes, as well as figures, are accessaries.

Accession (Lat. accessio). In International Law, the act by which one power enters into engagements originally contracted between other powers. The accession of a sovereign is the period at which he assumes the sovereignty, and in hereditary monarchies takes place immediately on the decease of his predecessor.

Accidens, per accidens (Lat.). A term used by the older philosophers to denote an effect not following from the nature or essence of the thing, but from some accidental quality. It is opposed to *per se*. Thus, fire burns *per se*; heated iron burns *per accidens*.

Accident. In Logic, one of the predicables: in its strictest logical sense, it is that which may be absent from or present in the subject, the essence of the species to which the subject belongs remaining the same. Thus, if it be predicated of a man, that he is 'walking,' or that he is 'a native of Paris,' the first expresses what is termed a separable accident; the latter, an inseparable; i. e. the individual may cease to walk, but cannot cease to be a native of Paris; but neither of these alters the species, man, to which the individual belongs. It is to be observed, with regard to the accident, as well as the other predicables, that they exist only relatively to each other; so that the same quality may be accidental when predicated of the species, which is a property when predicated of the individual. Thus, 'malleability' is an accident of the subject 'metal,' because many metals are not malleable. But it is one of the properties of gold, iron, &c., as distinguishing these from the non-malleable metals. [PREDICABLE.]

Accidental. In Heraldry, an additional mark in a coat of arms which may be either retained or omitted without altering its character.

Accidental Colours. Colours depending on the hypersensibility of the retina of the eye for complementary colours. If we look for a short time steadily with one eye upon any bright-coloured spot, as a wafer on a sheet of paper, and immediately after turn the same eye to another part of the paper, a similar spot will be seen, but of a different colour. If the wafer be red, the imaginary spot will be green; if blue, it will be changed into yellow; the colour thus appearing being always what is termed the complementary colour of that on which the eye was fixed.

Accidental Point. In Perspective, the point in which a straight line drawn from the eye, parallel to another straight line, cuts the perspective plane. It is the point in which the representations of all straight lines parallel to the original straight line concur when produced. It is called the accidental point, to

distinguish it from the principal point, or point of view.

Accidentals. In Music, are those flats and sharps which are prefixed to the notes in the course of a movement, and are not indicated by the signature at the commencement.

ACCIDENTALS. In Painting, are those fortuitous or chance effects, occurring from luminous rays falling on certain objects, by which they are brought into stronger light than they otherwise would be, and their shadows are consequently of greater intensity. This sort of effect is to be seen in almost every picture by Rembrandt, who used them to a very great extent. There are some fine instances of accidentals in Raphael's Transfiguration, and particularly in the celebrated picture, the *Notte* of Correggio, in which the light emanates from the infant Christ. With these effects may be classed such accidental lights as those from a forge or a candle, or some such object, of which the use is extremely important to the painter of still life.

Accipitres (Lat. accipiter, *a hawk*). The name of the Linnæan order including the birds of prey.

Acclimatise (Lat. ad, *to*, and clima, *a climate*). The supposed art of cultivating exotic plants so as to inure them to a climate different from that which is natural to them. An acclimatised plant or animal is said to differ from a naturalised one, in always requiring the assistance of art for its continuance in the adopted climate; the naturalised plant or animal continuing its kind without any care from man. It is, however, to be observed that what passes under these terms is frequently nothing more than the fortunate discovery that some plant or animal, which had hitherto been found in a warm climate, would thrive equally well in a cold one. It is doubtful whether any case of true acclimatisation is known among plants.

Accolade (Fr). The slight blow given to the neck or shoulder, on dubbing a knight.

Accompaniment. In Music, the instrumental part of a composition which moves with the voice, to which it is to be kept subordinate. Also, the parts which in a concerted piece move with a particular instrument, whose powers it is the object of the composition to exhibit.

ACCOMPANIMENT. In Painting, any object accessary to the principal subject, and serving to ornament or illustrate it.

Accord. [CONCORD.]

Accordion (Ital. accordare, *to harmonise*). In Music, a free reed portable instrument, something like the concertina, but inferior.

Account Stated. In Pleading (English Law), a 'count' in an action whereby the plaintiff alleges that the defendant is indebted to him in a certain amount on a statement of accounts between them.

Accountant-General. The principal or responsible accountant in the offices of Excise and Customs, India House, Bank of England, &c. The accountant-general of Chancery is an officer appointed by act of parliament to receive all the money lodged in court. He keeps his account with the Bank of England, which is responsible for all the sums lodged there by him.

Accrescent (Lat. accrescens, part. of accresco, *I grow*). In Botany, when an organ is persistent and increasing in size; as the calyx of the winter-cherry, which becomes enlarged after the plant has flowered.

Accrescimento (Ital.) In Music, the increase, by one half of its original duration, which a note gains by having a dot appended to the right of it.

Accumbent (Lat. accumbens, part. of accumbere, *to lie down*). A botanical term used in cases where one part of an organ is applied to another by its edge; in contradistinction to *incumbent*, where one part is applied to another by its back or face. These terms are principally employed among Brassicaceous (Cruciferous) plants.

Accumulation of Power. Power is said to accumulate when a certain force is exercised upon a body in motion, which is not able to be absorbed by that motion; or when a force is exercised upon a body in repose, which is not capable of relieving the power so accumulating. The measure of the power thus developed is to be found in the capacity of the machinery in action to resist the force thus exercised; or in the vis inertiæ of the body impressed with the motion, together with any additional efforts it may communicate. The accumulation of force is a great element of the blow with which a heavy body strikes the ground when falling from a height: it is also a matter of serious consideration with the locomotive builder, or the mechanical engineer, in designing their machinery. [GRAVITY; LOCOMOTIVE; STEAM ENGINE.]

Accusative Case. That inflection of the noun which expresses the passing over of an action from one substance to another: it consequently follows verbs active in all languages. The English language retains the inflected case only in the pronouns. [GRAMMAR.]

Acephalans, Acephala (Gr. ἀκέφαλος, *headless*). A term applied to a class of molluscous animals, comprehending those which are without a head. The class is subdivided, according to the modifications of the respiratory organs, into the 'Lamello-branchiate,' Pallio-branchiate,' and 'Hetero-branchiate,' or tunicate orders [which see]. The oyster, lamp-cockle, and squirter, or ascidia, are their several representatives. In the system of Cuvier it includes only the lamello-branchiate and hetero-branchiate orders, or the *Acephala testacea*, and the *Acephala nuda*. [CONCHIFERA.]

Acephali. In Ecclesiastical History, a name given to an Egyptian sect which renounced communion with the patriarch of Alexandria, because the latter had subscribed to the Henoticon of Zeno, A.D. 482. (Gibbon, *Roman Empire*, ch. xlvii.)

Acephalocyst (Gr. ἀ, priv., ἐγκέφαλος, *brain*, and κύστις, *bag*). A hydatid, or sub-

globular or oval vesicle, found in the cellular tissue, and filled with fluid. Its animal nature has been asserted by Kuhn and other zoologists. It is, however, probably a mere form of morbid and dropsical cell.

Acephalophores, Acephalophora (Gr. ἀκέφαλος, and φέρω, *I bear*). The name given by Blainville to a class of molluscous animals corresponding to the Acephala and Brachiopoda of Cuvier.

Acephalous. A Botanical term, occasionally employed to designate ovaries, the style of which springs from their base instead of their apex, as in *Lamiaceæ*.

Acer (Lat.). A genus of hardy trees, comprehending the common maple, the sycamore, and various kinds of American maples. Their wood is not of much value, being usually light and perishable; but the knotted parts of *A. campestre* furnish the pretty bird's-eye maple of cabinet-makers. The sap of *A. saccharinum* is so sweet that sugar of good quality is prepared from it in North America. *A. platanoides*, the Norway maple, is one of the best trees for planting in places exposed to the sea air.

Aceraceæ. [Acer.] A small natural order of polypetalous exogenous plants, comprehending the genus *Acer*, and a few others. It consists of trees, or at least of woody plants, inhabiting the temperate parts of the world; their most essential character consists in their samaroid dicarpellary fruit, connected with a broken-whorled calyx, and unsymmetrical flowers without scales at the base of the petals. The uses of the order are the same as those of *Acer*.

Acerans, Acera (Gr. ἀ, *without*, and κέρας, *a horn*). A name applied to a family of apterous insects, characterised by the absence of antennæ; and to a family of gasteropodous mollusks, including those species which have no tentacles.

Acerdese (Gr. ἀκερδής, *unprofitable*). The name given by Beudant to Grey Oxide of Manganese [Manganite], because it is of little use in the arts, compared with Pyrolusite, which it greatly resembles.

Aceric Acid (Lat. acer, *the maple*). An acid obtained from the sap of the maple tree.

Acerose. The word literally means chaffy (Lat. panis acerosus, *chaffy* or *brown bread*). Botanists apply the term to leaves of a narrow, stiff, and pungent nature, like those of fir trees.

Acerra (Lat.) A small altar, placed by the Romans near the couch on which a dead body was laid. Incense or other perfume was burnt upon it, originally, no doubt, to correct any offensive smell arising from the corpse. The name was also applied to the incense box itself.

Acetabulum (Lat. *a vinegar cruet*). A term applied to the suckers on the arms of the cuttle-fish and other dibranchiate cephalopods, which have been, hence, recently termed *acetabulifera*. These suckers were called by Aristotle *kotuloi*, which Taylor has erroneously rendered 'joints,' in the English translation of the *History of Animals*. In Anatomy, *acetabulum* signifies the cavity of the hip-joint. In Entomology it is the socket on the trunk in which the leg is planted.

Acetal (Lat. acetum, *vinegar*). A colourless inflammable liquid, obtained by the action of spongy platinum upon the vapour of alcohol; it is convertible by slow combustion into *acetic acid*.

Acetamide. A white crystalline body, derived from ammonia by replacement of an equivalent of hydrogen by acetyle. It is soluble in water.

Acetanilide. A crystalline solid derived from aniline by replacement of an atom of hydrogen by acetyle. It is soluble in hot water.

Acetarious Plants (Lat. acetaria, *salad*). Plants used in salading; such as lettuce, mustard and cress, endive, &c.

Acetates. Salts containing acetic acid. [Vinegar.]

Acetic Acid. The pure acid contained in vinegar. It is a pungent acrid liquid; its odour, when diluted, is agreeable and refreshing; when perfumed, it is known under the name of *aromatic vinegar*.

Acetic Ether. This liquid is a compound of acetic acid and ether. Its odour somewhat resembles that of apples. It is an odoriferous and flavouring constituent of many wines, and is easily made artificially by distilling a mixture of alcohol, oil of vitriol, and acetate of potash.

Acetification. The process by which wine, beer, &c., become converted into vinegar. It consists in the direct absorption of oxygen from the air by the alcohol contained in the liquors.

Acetines. Combinations of acetic acid with glycerine. They are oily bodies, and are prepared artificially.

Acetometer. A hydrometer used in determining the strength of acetic acids.

Acetone (Lat. acetum). When acetate of lime, baryta, or lead, is subjected to dry distillation, a limpid colourless liquid is obtained, to which the above name has been given: it has a penetrating aromatic odour, and is highly inflammable: its ultimate components are 3 atoms of carbon, 3 of hydrogen, and 1 of oxygen.

Acetonine. An alkaline liquid derived from the action of ammonia on acetone.

Acetonitrile. A liquid containing the carbon and hydrogen of acetic acid associated with nitrogen. Its more recent name is cyanide of methyle.

Acetous Acid. [Aldehydic Acid.]

Acetureide. Urea in which hydrogen is replaced by acetyle.

Acetylamine, Acetylia, or **Diethylenia.** An organic base derived from a double atom of ammonia by the replacement of two double equivalents of hydrogen by two of ethylene.

Acetyle. The hypothetical radicle of the acetic compounds: it is composed of four atoms of carbon and three of hydrogen. Its symbol therefore is C_4H_3, and that of the acetic acid $C_4H_3O_3$.

Acetylene. Of all known hydrocarbon gases this contains least hydrogen. It is present in small quantities in coal-gas, and has recently been formed from its elements artificially by passing a current of electricity from carbon points through hydrogen. It is interesting as the starting-point from which a number of organic bodies may be formed.

Achæan League. A confederacy which existed from very early times among the twelve towns of the province of Achaia, in the north of the Peloponnesus. It was broken up after the death of Alexander the Great, but was set on foot again by some of the original cities, B.C. 280, the epoch of its rise into great historical importance. From this time it gained strength, and finally spread over the whole Peloponnesus, though not without much opposition, principally on the part of Lacedæmon. It was finally dissolved by the Romans, on the capture of Corinth by Mummius, B.C. 147. The two most celebrated leaders of this league were, Aratus, the principal instrument in its extension, and Philopœmen, the contemporary and rival, in military reputation, of Scipio and Hannibal. (Polybius, i. ii.; Pausanias, i. vii.; Thirlwall, *History of Greece*, ch. lxi.; Freeman, *History of Federal Government*, vol. i. ch. v.; Clinton, *Fasti Hellenici*.)

Achæne, or **Achenium** (Gr. ἀ, neg., and χαίνω, *I gape*). A small bony fruit, containing a single seed, which does not open when ripe.

Achatina. A genus of terrestrial gasteropods, known by the trivial name of agate-snails: characterised by an oval oblong ventricose shell, striated longitudinally; with the aperture ovate and never thickened or reflected, and a smooth, straight columella, truncated at the base. All the species are oviparous, and one, the *Achatina Zebra*, produces eggs with a hard, white, calcareous shell, and as large as those of the sparrow.

Acheron. A river in the nether world of Hades, usually derived from the Greek word ἄχος, as if flowing with pain and sorrow. Two rivers of the same name, one in Thesprotia, the other in Italy, were supposed, from the foulness of their waters, to be connected with this stream. The name probably comes from the root to which belong *Achelous, Axius, Oxus*, and the many other variations, all expressive of flowing waters.

Achievement (Fr. achèvement, from achever, *to accomplish*). In Heraldry, denotes generally a shield of armorial bearings; but is more particularly applied to the funeral shield, commonly called hatchment, affixed to the dwelling-house of a recently-deceased person. The achievement is various, according not only to the rank of the deceased party, but to his situation as single, married, or widower.

Achilleine. A peculiar bitter principle procured from the *Achillea millefolia*.

Achirite. The name given by Werner to Dioptase, after Achir Mahmed, who first brought the mineral from Siberia.

Achlamydeous (Gr. ἀ, priv., and χλαμύς, *a tunic*). Plants which have neither calyx nor corolla; whose flowers are destitute of all covering.

Achmatite. A variety of lime-and-iron Epidote from Achmatowsk. [BUCKLANDITE.]

Achmite. A mineral found near Kongsberg in Norway. It is a double silicate of iron and soda, and is supposed by G. Rose to be an altered form of Pyroxene.

Achroite (Gr. ἀ, neg. and χροία, *colour*). The name proposed by Rammelsberg for colourless varieties of Tourmaline.

Achromatism. The destruction of the coloured fringes which accompany the image of an object seen through a prism or lens. Light is not homogeneous, but compounded of rays unequally refrangible, and differing from one another in other physical properties. In passing into a refracting medium, some of the rays are more refracted, or bent out of their course, than others; whence the image of an object, seen through a lens, is rendered confused and indistinct, and appears encircled by a coloured ring. This circumstance presented a formidable obstacle to the use of the telescope; and, accordingly, soon after the invention of that instrument, the utmost efforts of mathematicians and artists were exerted to remove the imperfection. The compound nature of light, and, consequently, the theory of unequal refrangibility, were, however, not known till the time of Newton; and after the true source of the difficulty had been discovered, it continued for a long time to be believed that achromatism was impossible, or that light could not be refracted without being decomposed. Newton himself was led to this conclusion by imperfect experiments. Subsequent discoveries have proved that the conclusion was erroneous, and that the rays of light may be bent without being separated; but, after all the progress that has been made in practical optics, as well as in the theory of colours and light, the subject of achromatism continues to be one of the most delicate and embarrassing, both in regard to theory and practice.

The principles on which achromatism is effected may be briefly explained as follows. On observing the spectra formed by prisms of different substances, it is soon perceived that the different colours, though always ranged in the same order, do not occupy the same relative lengths. Hence it follows, that the primary coloured rays, in passing through different substances, do not undergo the same relative refractions; that is to say, the angle formed by two rays, the red and the violet, for example, is greater when the light is refracted by some substances than when it is refracted by others, though in all substances the violet is more refracted than the blue, the blue more than the green, and so on. The angle formed between the extreme rays of the spectrum measures the *dispersion* of the rays; and it is found by experiment that the dispersive power of common flint glass is to that of crown glass in the ratio of about 3 to 2; so that if a prism of flint glass

give a spectrum three inches long, a similar prism of crown glass will give a spectrum of only two inches.

Two prisms may therefore be so arranged the one behind the other, that the chromatic effect of the first may be neutralised by that of the second, so as to destroy colour, but still retain a certain amount of refraction.

The achromatism of lenses depends on the same principles as that of prisms; but compensation is attended with great practical difficulties, on account of its being necessary to have regard to the spherical aberration.

If the ratios of the dispersion of the different spectral colours were all equal, the achromatism would be perfect when the extreme rays, or, indeed, any two rays, emerge parallel. This, however, is not generally the case; these ratios are in general variable, and, therefore, the angle which renders the red and violet rays parallel is not that which is required for the intermediate colours. It is possible, however, to remedy this defect, by combining a greater number of prisms or lenses. Theoretically speaking, indeed, the number of rays united or rendered parallel is the same as the number of prisms. The achromatic object-glasses of telescopes formerly made in this country, were generally triple—that is to say, consisted of three lenses, namely, a concave lens of flint glass placed between two lenses of crown glass; but almost all the large object-glasses lately constructed consist of only two lenses; the achromatism produced by this combination, though not rigorously exact, being sufficient for optical purposes.

The possibility of refracting light without producing colour was discovered and experimentally proved by Mr. Hall, a country gentleman of Worcestershire, under whose directions an achromatic telescope was made by a London artist in 1733. But, from whatever cause, no notice was taken of Hall's discovery; indeed, it appears to have been entirely forgotten, and contributed nothing whatever to advance subsequent researches. The merit of the discovery of achromatic compensation belongs to John Dollond, who arrived at it through a long course of skilful and systematic experiments undertaken for the express purpose. Its possibility had, indeed, been previously asserted by the celebrated Euler, who, reasoning from the construction of the eye, which, indeed, is a perfect achromatic instrument, proposed various hypotheses for destroying the coloured images. After Dollond's discovery, the subject was examined theoretically by Euler, Clairaut, and D'Alembert, but their profound mathematical investigations led to no practical improvement. The object-glasses made by Peter Dollond (a son of the inventor) were long celebrated throughout Europe as the best that were manufactured. Of late years, however, the science of light has been vastly extended; and the discoveries of Fraunhofer, in particular, have opened up an entirely new view of the composition of the spectrum. The largest and best achromatic glasses have recently been made in Bavaria by Mertz and Steinheil, and in this country by Dalmayer and Cooke.

Achras (Gr. ἀχράς, *a wild pear*). A genus of *Sapotaceæ*, containing the Sapodilla plum, *A. Sapota*, whose elliptic fruit, larger than a quince, has an agreeably tasted yellow flesh; but the seeds are aperient and diuretic. They are milky trees, with entire leathery leaves.

Achtaragdite. A doubtful mineral found in greyish-white or greenish-grey pyramidal tetrahedrons, on the banks of the river Achtaragda in Siberia, associated with Idocrase, Wiluite, and Grossular. According to Breithaupt, Achtaragdite is a pseudomorph derived from the alteration of Helvine.

Acicular (Lat. acicula, *a needle*). Anything that is slender, sharp-pointed, and rather stiff; as many kinds of prickles on the leaves of plants, &c. In Mineralogy, a term applied to long, slender, and straight prisms.

Aciculite. A Mineralogical name for Needle Ore.

Acid. In common language, any *sour* substance; in Chemistry the term is less restricted, and often applied to all substances which saturate and neutralise the alkalis and other salifiable bases, without other obvious acid properties.

Acidimeter (Lat. acidus, *acid*, and Gr. μέτρον, *measure*). An instrument for determining the strength of an acid by its saturating power: it usually consists of a glass tube graduated into 100 equal parts, and containing an alkaline liquor of known strength, the proportion of which, requisite to saturate a given quantity of any acid, is the equivalent of that acid. [ALKALIMETER.]

Acidulous. *Dim.* of acid. Subacid; a term frequently applied to mineral waters containing carbonic acid.

Acinaciform (Lat. acinaces, *a scimitar*, and forma, *shape*). A name applied to certain succulent leaves and fruits, which resemble the blade of a curved sword or Turkish scimitar.

Acineta (Gr. ἀκίνητα, from ἀ, priv., and κίνησις, *motion*). A genus of *Infusoria*, allied to *Vorticella*; and supposed by many authors to be one of the transformations of that genus, the cyst of which is, according to Stein, converted into an *Acineta* by the protrusion from its exterior of the characteristic knobbed tentacles.

Acinus (Lat., from Gr. ἄκινος, *the stone of a grape*). The separate carpels of a succulent fruit consisting of many carpels; as the raspberry. This term is also applied in Anatomy to a cluster of the ultimate secerning follicles of certain conglomerate glands; as the liver.

Acipenser (Lat. *a sturgeon*). The name of a Linnæan genus of the *Amphibia nantes*, characterised by solitary, lateral, linear gill-openings; the mouth, situated beneath the head, retractile and edentulous; feelers under the snout, in front of the mouth. The sturgeon (*Acipenser Sturio*), and most of the other *Amphibia nantes* of Linnæus, form the order *Chondropterygii*, or cartilaginous fishes of Cuvier. The genus *Acipenser* is separated by Agassiz

from the other cartilaginous fishes. It forms a link between the osseous and cartilaginous fishes, having its gills protected by an operculum, and only a single issue, or gill-opening, on each side for the respiratory currents; but at the same time having no rays to the branchiostegal membrane, and having the whole of its true internal skeleton in a cartilaginous state. It is classified by modern ichthyologists in the placoganoid order of fishes. Its flesh, like that of most cartilaginous fishes, is firmer than is usual among osseous fishes, and, having little peculiar flavour of its own, affords ample scope for the skill of the cook in imparting to it an extrinsic zest. In the northern parts of Europe this fish is much more numerous than in the British rivers, and extensive fisheries are established for its capture. The best isinglass is manufactured from the sound, or air-bladder; and caviare is prepared from the roe of the female.

Acis. In the mythology of Ovid, was a son of Faunus and the nymph Symæthis, killed by Polyphemus, because he was loved by Galatea. (Ovid, *Met.* xiii. 750.)

Acknowledgement Money, in Law, paid according to the custom of some manors by copyhold tenants, on the death of a lord.

Acme (Gr. ἀκμή, *a point*). In Rhetoric, the extreme height, or farthest point of pathos or sentiment, to which the mind is judiciously conducted by a series of impressions gradually rising in intensity. [Climax.]

Acollé (*collared*, from Fr. col, *the neck*). In Heraldry, denotes animals with collars, &c., about their necks, batons or swords placed saltier-wise behind the shield, or two things joined together.

Acology, or **Akology** (Gr. ἄκος, *a remedy*, and λόγος, *a discourse*). The doctrine of remedies, or of the materia medica.

Acolyte (Gr. ἀκόλουθος, *a follower*). The second of the inferior orders of clergy in the primitive church, according to the Roman Catholic authorities. The Council of Trent declares the inferior orders to be five—subdeacons, acolytes, exorcists, readers, and doorkeepers; considering them all to be of apostolical institution. By the Protestants they are supposed to be merely occasional or local officers. The office of the acolytes, according to the Roman Catholic *Catechismus ad Parochos*, is to follow and serve the superior orders, the subdeacons and deacons, in the ministry of the altar.

Aconite (said to be so named from Acone, a place in the Crimea famous for its poisonous herbs). A genus of exogenous plants belonging to the natural order *Ranunculaceæ*, with white, purple, or yellow helmet-shaped flowers growing in panicles, deeply-cut leaves, and perennial roots of a highly poisonous nature. Those of *Aconitum Lycoctonum* are used for the destruction of wolves, and of *A. Napellus* for certain medicinal purposes; they are exceedingly acrid, and act as violent drastic purgatives. The bish root, with which the natives of Nepal poisoned their wells during the advance of the British army into their territory, was furnished by *Aconitum ferox*. The name aconite has also been given to another plant related to the original genus, namely, *Eranthis hyemalis*, or winter aconite.

Aconitic Acid. A crystalline body existing in the aconite and some other plants. Thus, it occurs in the river equisetum, and hence is sometimes termed *equisetic acid*. It is, however, most easily obtained from the residue of the distillation of citric acid, and is therefore occasionally called *citridic acid*.

Aconitine, Aconitina. An intensely poisonous alkaloid contained in the *Aconitum Napellus* or monkshood. It is a solid, forms salts with acids, and is sometimes used by surgeons to produce contraction of the pupil of the eye.

Acontia (Gr. ἄκων, *a dart*). A genus of non-venomous ophidian reptiles, allied to the snakes proper (*Anguis*), but destitute of the bony rudiments of the scapular and pelvic arches. They are known by the trivial name of 'Dart-snakes;' are numerous in species, and distributed over the warmer and more arid parts of the Old World. They were the subjects of fabulous accounts by the ancient naturalists and poets, who attributed to them the power of projecting themselves with so much force and velocity as to transfix the object aimed at, like a hurled javelin, or arrow shot from a bow. This is as untrue as the assertion that they are venomous. The Dart-snakes are amongst the most harmless of their order; their food consists of small worms, insects, and larvæ.

Acoraceæ. The natural order of plants which includes the genus *Acorus*. It is distinguished from *Araceæ* only by having its carpels separate, and its leaves in the bud state arranged in an equitant manner.

Acorn. (Sax. accorn, from aac, *an oak*, and cern, *grain*). The well-known fruit of the oak, and therefore not a term of art, though belonging to architecture from its use as an ornament. In the early ages acorns, it is said, constituted part of the food of man (Ovid, *Metamorph.* i. 106; Virgil, *Georg.* i. 8, &c.). At present they are occasionally used, as in Spain, under the name of Bellotes; but in England never, except for the feeding of pigs, poultry, &c.

Acorus (Gr. ἄκορος). A plant with sword-shaped leaves and aromatic stems, found abundantly in the meadows of some parts of England. It bears, but very rarely, its flowers in a little greenish-yellow spadix, which appears at a short distance below the end of a leaf-like scape. The leaves, when crushed, exhale a pleasant odour, and are still used for strewing the floors of churches upon the occasion of certain ancient ceremonies. Its stem, or rhizoma, is like that of an iris. It is the *Calamus aromaticus* of the druggists.

Acotyledons (Gr. ἀ, priv., and κοτυληδών, literally, *a hollow or concave part*, but applied by botanists to the seed-lobe). Plants whose embryo has no distinct cotyledons. The term is usually applied to what are more commonly named cryptogamic plants, such as ferns, mosses, lichens, &c., in which there are no seeds,

properly so called, but which are propagated by undivided spheroidal bodies called spores. The word acotyledon is occasionally used for such plants as *Cuscuta*, *Cactus*, &c., whose embryo, although really of the same nature as those in which cotyledons are usually present, has no obvious division; this mode of applying the term is, however, seldom employed.

Acotyledonous (Gr. ἀ, priv., κοτυληδών, a seed-lobe). Not having cotyledons or seed-leaves. The term is sometimes applied to the cryptogamous plants, in contradistinction to the phanerogamous plants, which latter are either monocotyledonous or dicotyledonous.

Acoustics (Gr. ἀκουστικός, from ἀκούω, *I hear*). The science of hearing, or of sound. [Music; Sound.]

Acquittal (Fr. acquitter, *to free*). In Law, a deliverance and setting free of a person from the suspicion or guilt of an offence; also freedom from entries and molestations by a superior lord for services issuing out of lands. There are two kinds of acquittal: 1. Acquittal in deed, when a person is cleared by verdict; and 2. Acquittal in law, as if two be indicted for felony, the one as principal, the other as accessory, and the jury acquit the principal, by law the accessory is also acquitted. (Wharton's *Law Lex.*)

Acquittance. In Law, the discharge in writing of a sum of money due. An acquittance not under seal is admissible only in evidence, and is not pleadable. An acquittance in full of all demands, is an answer to all debts, except such as are on specialty, which can only be discharged by an instrument of equal force.

Acre (Germ. acker, Gr. ἀγρός, Lat. ager). A measure of land equivalent to 4840 square yards. The acre is divided into 4 roods, and each rood into 40 perches; so that a perch contains $30\frac{1}{4}$ square yards. [Measure.] Formerly the acre differed in magnitude in different parts of the United Kingdom. 121 Irish acres were equivalent to 196 English acres; 48 Scotch acres were equivalent to 61 English acres. The French *are* is equivalent to 100 square metres, so that 1000 English acres are equivalent to 40467 French *ares*.

Acre-fight. A kind of duel, fought in ancient times by single combatants, English and Scotch, between the frontiers of their kingdoms.

Acridians, Acridia (Gr. ἀκρίδιον, dim. of ἀκρίς, *a locust*). A family of orthopterous insects, having the genus *Acridium* for the type.

Acridium. The name applied by Fabricius to a genus of locusts, characterised by a carinate thorax; filiform antennæ, shorter than the thorax; and equal palps or feelers.

Acrites, Acrita (Gr. ἄκριτος, *not discernible*). The lowest division of the animal kingdom, in which there is no distinct discernible nervous system; and in which the alimentary canal is not separated from the parietes of the body, or contained in a distinct abdominal cavity. It is composed of the classes *Infusoria*, *Foraminifera*, and *Amorphozoa*, [which see]. The division is also termed *Protozoa*.

Acroamatic (Gr. ἀκροαματικός, from ἀκροάομαι, *I hear*). A term used in the Aristotelian schools, signifying lectures intended only to be heard by that philosopher's intimate friends and disciples, instead of being committed to writing. They were also called *esoteric*, as distinguished from *exoteric*, or those adapted to a common auditory.

Acrodactylum (Gr. ἄκρος, *highest* or *extreme*, and δάκτυλος, *a digit*). In Zoology, the upper surface of each digit.

Acrodus (Gr. ἄκρος, *extreme*, and ὀδούς, *tooth*). The name of a genus of sharks, characterised by the presence of large polygonal obtuse enamelled teeth, aggregated at the extremity of the jaws. The fishes of this genus are found exclusively in the fossil state.

Acrogens (Gr. ἄκρος, and γίγνομαι, *I grow*). Plants, otherwise called cryptogamous and acotyledonous. They correspond to ferns, mosses, lichens, &c.; have no sexes; are multiplied by spores instead of seeds; and are remarkable for increasing chiefly in length by additions to their end, and not in diameter by the addition of fresh matter to their outside, as in exogens, or to their inside, as in endogens.

Acroleine (Gr. ἄκρος, and Lat. oleum, *oil*). An acrid volatile product, formed during the destructive distillation of the fat oils: it appears to arise from the decomposition of glycerine.

Acrolithos (Gr. ἀκρόλιθος). In Sculpture, a statue in which the parts not covered with drapery, namely, the face, hands, and feet, were made of marble, the rest being composed of wood. Statues, so made, mark the intermediate stage between the employment of wood only and the construction of the statues termed *chryselephantine*.

Acromion (Gr. ἀκρώμιον, from ἄκρος, highest, and ὦμος, *shoulder*). A term in Anatomy for the large process which terminates the scapular spine above and outwards, and receives on its articular surface the scapular extremity of the clavicle. It affords attachment to the deltoid and trapezius muscles.

Acromonogrammaticum (Gr. ἄκρος, μόνος, *only*, and γράμμα, *a letter*). A poetical composition in which every verse begins with the same letter as that with which the preceding verse terminates.

Acronycal (Gr. ἄκρος, and νύξ, *night*). A star or planet is said to be acronycal when it is opposite to the sun, or passes the meridian at midnight. It rises acronycally, when it rises as the sun sets; and sets acronycally, when it sets as the sun rises. The Greek poets designated these different positions of a star, at its rising or setting, with respect to the sun, by the terms *acronycal*, *cosmical*, and *heliacal*; and thereby indicated, in a rude way, the position of the sun in the ecliptic, or the season of the year.

Acropodium (Gr. ἄκρος, and πούς, *foot*). In Zoology, the upper surface of the whole foot.

Acropolis (Gr. ἄκρος, and πόλις, *city*). The upper town or citadel of a Grecian city. It was usually the site of the original settlement, and was chosen by the colonists for its natural strength. The most celebrated were those of Athens, Corinth, and Ithome. That of Athens was especially remarkable for its buildings and works of art, the Parthenon, Erechtheion, &c. (*Edinburgh Review*, July 1859, *art.* 'Acropolis of Athens.')

Acrospire (Gr. ἄκρος, and σπεῖρα, *a curved line*). When seeds begin to grow, the part of the germ which afterwards produces the stem shoots forth in the form of a delicate curved thread, and, gradually bursting the outer covering, makes its appearance at the end of the seed. Maltsters, especially, call this the acrospire of barley.

Acrostic, or **Acrostich** (Gr. ἀκρόστιχον, from ἄκρος, and στίχος, *line* or *rank*). A short poem, in which the first or last letters of every line form a name or a sentence. Great labour and ingenuity have been exercised in inventing varieties of this and similar curious trifles. Such, for example, is the pentacrostic, in which the initial letter of each verse is repeated five times in the verse, so as to form five repetitions of the same acrostic in different columns.

Acrotarsium (Gr. ἄκρος, and ταρσός, *tarsus*). In Zoology, the upper surface of the tarsus.

Acroteria (Gr. ἀκρωτήρια, *extremities*). In Architecture, the small blocks, or pedestals, which are placed at the apex and at the extremities of pediments, to receive statues, trophies, or other emblematic sculpture.

Acrydium. [Acridium.]

Acryl. The hypothetical radicle of which acroleine is the hydride.

Acrylic Acid. Oxidised acroleine. It bears the same relation to acryl and acroleine that acetic acid does to acetyle and aldehyde.

Act (Lat. actus). In Dramatic literature, a division of a drama, subdivided into scenes. The Greek dramas of the old model were naturally divided into separate portions by the stasima, or choric odes, which occur at intervals, during which the stage was left to the sole occupation of the chorus. Nevertheless, the Greek writers do not notice this division in express terms; nor do we know the origin of the famous rule of Horace, that every dramatic piece should be restrained within the limits of five acts, neither more nor less. The division into acts must be in great measure arbitrary, although rules have been laid down, by various writers, to define the portion of the story or plot which should be contained in each of them. Thus, Vossius lays it down as a rule, that the first act presents the intrigue, the second developes it, the third is filled with incidents forming its knot or complication, the fourth prepares the means of unravelling it, which is finally accomplished in the fifth. [Drama.]

Act. In the Universities, an exercise performed by students before they are admitted to degrees. The student proposes certain questions to the presiding officer of the schools, who then nominates other students to oppose him. The discussion is syllogistical and in Latin, and terminates by the presiding officer questioning the respondent, or person who is said to keep the act, and his opponents, and dismissing them with some remarks upon their respective merits. The practice has fallen into disuse at Oxford.

Act of Grace. In Scotch Law, an act passed in 1696, which provides maintenance for debtors while in prison at the suit of their creditors.

Act of Parliament. [Statute.]

Acta Diurna (Lat. *daily proceedings*). Among the various important improvements effected by Julius Cæsar may be ranked that of his furnishing the Romans with a species of newspaper. He was the first to order that the *acta diurna* of the senate and the people should be drawn up in a regular form and published. This publication must consequently have, in many important respects, closely resembled a modern newspaper. (Sueton. *In Cæs.* cap. xx.)

Actian Games (Lat. ludi Actiaci). Games celebrated in antiquity at Actium in honour of Apollo, hence surnamed *Actius*. The temple of the god was repaired, and the games restored and celebrated with increased splendour, by Octavius, afterwards the Emperor Augustus, in memory of his victory over Mark Antony off Actium.

Actinia (Gr. ἀκτίς, *a ray*). A genus of *Anthozoa* with very numerous tentacles, which extend, like rays, from the circumference of the mouth. They are amongst the most highly organised of the class, having the alimentary sac distinct from the parietes of the body; feeding on shellfish and other marine animals, which they draw into their mouth with their tentacula, and in a short time rejecting, through the same aperture, the shells and indigestible parts. They are of a soft gelatinous texture, and they assume various forms when the tentacles are all expanded, having the appearance of full-blown many-petalled flowers; whence they are called 'sea anemones,' 'sea sunflowers,' &c. (*Phil. Trans.* lxiii. p. 361.)

Actinism (Gr. ἀκτίς, *a ray*). A name recently given to that property of the sun's rays which effects chemical combinations and decompositions, as shown in the processes of photography, in contradistinction to their heating and illuminating powers. [Light.]

Actinocamax (Gr. ἀκτίς, *a ray*, and κάμαξ, *a pale*). A name applied by Miller to the fossil shells of an extinct genus of cephalopodous mollusks, apparently connecting the *Belemnites* with the existing *Sepiæ*. The remains of the *Actinocamax* appear as yet to be peculiar to the chalk formations of England and Normandy.

Actinocrinites (Gr. ἀκτίς, *a ray*, and κρίνον, *a lily*). The name of a subgenus of extinct crinoidean radiated animals, or encrinites, characterised by the numerous rows of angular plates, which, being articulated by their margins, constitute the body.

Actinograph (Gr. ἀκτίς, *a sunbeam*, and γράφω, *I write*). An instrument for the purpose of registering the variations of chemical influence in the solar rays, the intensity of which has been found to bear no direct relation to the quantity of light, but to vary at different periods of the day and year. The instrument, as contrived by Mr. Hunt, and described to the British Association, 'consists of a fixed cylinder, on which is placed a prepared photographic paper. This is covered by another metal cylinder, which revolves once in twenty-four hours. In this there is a triangular opening divided by fifty bars, through which the paper is exposed to the sunshine. As the time during which the smallest part of the opening allows the paper to be exposed is one hundred times less than the time during which it is exposed by the largest opening, different effects are produced on the paper, and consequently a register for every hour of the day may be numerically kept of the actinic radiation associated with light.' (*British Association Reports* for 1845 and 1846.)

Actinolite (Gr. ἀκτίς, *a ray*, and λίθος, *stone*). A name under which are comprehended the glassy, asbestiform, and granular varieties of Hornblende.

Actinometer (Gr. ἀκτίς, *a sunbeam*, and μέτρον, *measure*). An instrument invented by Sir John Herschel for measuring the force of solar radiation. It consists of a hollow cylinder of glass soldered at one end to a thermometer tube terminating at the upper end in a hollow ball drawn out to a point, and broken off so as to leave the end open. The other end of the cylinder is closed by a silver, or silver-plated, cap cemented on it, through which a screw, working in a collar of leather, passes into the interior of the cylinder, and gives the means of increasing or diminishing the hollow capacity of the cylinder to a small extent at pleasure. The cylinder is filled with a deep-blue fluid (the ammonio-sulphate of copper); a graduated scale is applied to the stem, or thermometer tube, and the instrument is defended from currents of air by being enclosed in a case having the interior of three of its sides blackened, and the fourth, or face, composed of a thick plate of glass.

Before using the instrument for observation, any air-bubbles in the cylinder must be carefully expelled. This is easily effected by means of the screw and the ball at the top of the stem, which serves as a reservoir, and contains a small portion of superfluous liquid. When the ball and stem are both filled, and no air-bubble is left, the fluid is brought down to the zero of the scale by turning the screw.

The general object is to determine the expansion of the liquid produced by the exposure of a given area of the cylinder to the direct rays of the sun during a given interval of time. But as the expansion of the liquid depends not only on the heating power of the sun, but also on the rapidity with which the heat received is radiated away, and on every other circumstance exerting a thermometrical influence, it is necessary to eliminate those influences. For this purpose the observations are made with the instrument alternately exposed to and screened from the solar rays for intervals of one minute.

On exposure to the sun, the liquid in the stem rises rapidly, and the difference of the readings of the scale at the beginning and end of the interval of exposure shows the combined effect of all the heating and cooling influences. The instrument is then placed in the shade during an equal interval. If during this second interval the liquid remains stationary, then it may be inferred that the rise in the first interval was due to the solar action alone. If the liquid *falls* during the shade observation, then it is manifest that the solar action is opposed or counteracted by the cooling influences, and the number of divisions through which the liquid falls must be *added* to the number through which it rose in the interval of exposure, in order to have the measure of the solar action. But if the liquid continues to *rise* during the shade observation, then it is plain that the action of the solar rays is assisted by other heating influences, and the number of divisions through which the liquid rises in the second interval must be *subtracted* from the number through which it rose during the first.

The observations are made in triplets; that is to say, the instrument is held in the sun's rays one minute, then one minute in the shade, and again one minute in the sun, an interval of 20 or 30 seconds being interposed at each change for the purpose of noting the readings. The difference of the readings at the beginning and end of each minute interval is taken, and the difference in respect of the second interval is added to or subtracted from the mean of the two differences in respect of the first and third. A complete actinometer observation, however, cannot consist of less than three sun observations and two shade observations intermediate; but the more there are taken the better.

It will be readily seen that the results obtained, as above described, are only relative; some positive determination must therefore be had recourse to before the indications given by any two instruments are comparable. This is a matter of much difficulty. No doubt it is possible to determine for every instrument both the area of the section of the sunbeam which falls on the bulb and is effective in raising the temperature, and also the absolute quantity of liquid in the capillary tube, corresponding to any length on the scale; or, which comes to the same thing, to determine the value of the parts of the scale in water grains, or some other absolute measure. But even this would not be sufficient; for, in so delicate an experiment, the slightest difference in the thickness or composition of the glass would produce discrepancies, and no two plates of glass are ever found to be precisely the same in respect of the proportion of calorific rays they stop or absorb. Hence, the only means of discovering the relation between the results given by two instruments

is to make a series of experiments with both together, and under precisely the same circumstances. Sir John Herschel proposes to adopt as the *actine*, or unit, that intensity of solar radiation which, at a vertical incidence, and supposing it to be wholly absorbed, would suffice to melt one-millionth part of a *metre* in thickness from the surface of a sheet of ice horizontally exposed to its action in one minute of mean solar time.

In the *Philosophical Transactions* for 1842 Professor Forbes, of Edinburgh, has given an account of some interesting experiments with the actinometer, made by him on the Faulhorn (in Switzerland), for the purpose of ascertaining the difference of solar radiation at the bottom and top of the mountain, and thence the proportional quantity of calorific rays absorbed in passing through a stratum of the atmosphere of a given thickness. This is one of the most useful purposes to which the instrument can be applied. It may also be used for measuring the defalcation of heat in an eclipse of the sun.

The actinometer was first described in the *Edinburgh Journal of Science*, vol. iii. for 1825. For a full description of the instrument, and of the method of using it, see the *Report of the President and Council of the Royal Society on the Objects of scientific Inquiry in Physics and Meteorology*, 1840. [PHOTOMETRY.]

Action. In Mechanics, denotes sometimes the effort which a body or power exerts against another body, sometimes the effect or motion resulting from such effort. Mechanical action is exerted either by percussion or by pressure; in the former case, the effect is instantaneous, in the latter it is continued. In all cases of mechanical action, the effect of the acting body is resisted in an equal degree by the inertia of the body acted upon, which resistance is termed *reaction*; and it is an axiom in mechanics, that action and reaction are always equal, and exerted in opposite directions. Thus, in driving a nail with a hammer, the stroke acts against the face of the hammer exactly with the same energy as against the head of the nail; and in pressing the hand against a stone, the pressure on the hand and on the stone is precisely the same.

ACTION. In the Military art, an engagement or battle between opposing forces; hence *partial* actions, *general* actions, &c.

ACTION. In Oratory, the accommodating or suiting of the countenance, voice, and gesture of the speaker, to the matter to be spoken or delivered. This *sermo corporis*, as Cicero calls it, has always been regarded as a most important part of oratory. The ancient masters laid the greatest stress upon it, and Demosthenes asserted that action was 'the beginning, the middle, and the end of the orator's office.'

ACTION. In Painting and Sculpture, the state of the subject as imagined in the artist's mind at the moment chosen for representation. It must not be confounded with motion, which relates to the mobility of a single figure. Action must be true, simple, natural, and connected; and its unity must be preserved, or the action is weakened. In painting, all action represented is supposed to be simultaneous, or the unity of the picture is destroyed.

ACTION. In Poetry, an event either real or imaginary, forming the subject of an epic poem or play, &c. Thus, the wrath of Achilles forms the action or subject of the Iliad, the wanderings of Æneas the action or subject of the Æneid, &c.

ACTION. In the stock market in Paris, and other places in France, *action* is the name given to a share of the capital of a joint-stock company.

Actions in Law are real, personal or mixed. Actions, real or mixed, for the recovery of real property, are very numerous, but so prolix and difficult that they are almost wholly abandoned as a means of obtaining justice. The only case in which they have been resorted to, in recent times, has been when, from the shorter period to which the action of ejectment was limited [LIMITATIONS], a right survived for the purpose of the former, which was barred as to the latter. Actions in common use, i. e. personal actions, are divided into actions of contract and actions of tort, and into local and transitory, in the former of which the place or county where the cause of the action arose must be accurately alleged, for the purpose of the trial taking place there. The allegation is termed the *venue* of the action, from the Norman-French *visne*, (Lat. *vicinitas*,) neighbourhood, because the jury impanelled to try an action came originally from the neighbourhood. In transitory actions it is immaterial. Actions of tort to the person, and all actions of contract, are generally transitory, but under certain circumstances the latter may be local. As to recent alterations, see PLEADING.

Active Molecules. [MOLECULES.]

Actor (Lat.), **Actress.** In the flourishing period of the early Greek drama, so long as a certain remnant of religious solemnity was attached to it, there was no degradation in the character of an actor: in fact, the parts of the chorus were often filled by volunteer performers of birth and station. But when the dramatic performers began to form a profession apart, they appear soon to have been regarded with disrespect. In Rome, the first actors were buffoons (known by the Tuscan name of *histriones*), who enacted the grotesque farces imported from Etruria, and the qualification of actor was among the most dishonourable in the period of the republic; nor was any circumstance considered to indicate more decisively the intention of Nero to degrade and subject all classes in the state, than his having persuaded a Roman knight, Laberius, to appear on the stage in the performance of one of his own mimi. Under the dissolute reigns of the first emperors, especially Nero, much favour and countenance was shown to actors. Nero was, however, obliged at last to banish the *pantomimi*, the most popular species of actors, entirely from

Italy, together with their performances, in consequence of the strong party spirit which was excited about them. (Sueton. *Nero*, c. 16.) It seems from Tacitus, that they were soon afterwards restored; again banished by Domitian; restored by Nerva; and finally expelled by Trajan; but, by the time of the reign of the last-mentioned emperor, the dramatic stage was nearly abandoned, and its place wholly occupied by gladiatorial shows and other pageants. In England, the first actors were the servants of great nobles, who performed for their diversion; and when regular theatrical companies were formed, they were long in the habit of putting themselves under the protection of distinguished personages: the companies of the greater theatres, as is well known, retained in modern times the custom of calling themselves servants of His Majesty. Actresses were not known on the English stage until some time after the Restoration: although ladies of quality had frequently, under James and Charles I., performed parts in masques, &c. Kynaston was the last celebrated male performer of female parts: a singular notice of him will be found in Pepys's *Memoirs*. In Roman Catholic countries, actors, even to this time, are under the ecclesiastical restriction of excommunication. [DRAMA.]

Acts of Sederunt. In Scotch Law, statutes made by the Lords of Session *sitting* in judgment, by virtue of a Scottish act of parliament, passed in 1540, empowering them to make such constitutions as they may think expedient for ordering the procedure and forms of administering justice.

Actuary. Originally a public officer in the Roman courts of justice, who drew up writings, contracts, &c., in the presence of the magistrate; whence his name, from actus, *an instrument*. Actuarii also kept the military accounts of the Romans, and distributed the corn to the soldiers. The clerk who registered the acts and constitutions of the convocation, in the assemblies of that body, was termed *actuary*. A calculator of the value of life interests, annuities, &c., is usually termed in England an *actuary*. [INSURANCE.]

Aculeate (Lat. aculeatus, from aculeus, *a prickle*). In Botany, anything covered with prickles; that is, with sharp prominences which originate in the cellular system and have no connection with wood.

Aculeates. In Zoology, a tribe of hymenopterous insects, in which the females and neuters are provided with a sting, generally concealed within the last segment of the abdomen.

Acuminate (Lat. acuminatus, from acumen, *the point of anything*). When a leaf or any other body is very much tapered to a point; it is thus distinguished from *acute*, which means sharp-pointed without any tapering.

Acupuncturation (Lat. acus, *a needle*, and punctura, *a puncture*). Pricking with a needle. In the East this is a common remedy for painful affections of different parts of the body. It has lately been extensively practised for the cure of chronic rheumatism, a long and sharp needle being thrust into the affected muscles.

Acute (Lat. acutus, *sharp*). In Music, the height or pitch of a sound or tone, in respect of another. It is opposed to *grave*.

Acute Angle. An angle less than a right angle. [ANGLE.]

Ad libitum (Lat. *at pleasure*). In Music, a term applied to an accompaniment which is not essential, and may or may not be performed without interfering with the composition.

Ad quod Damnum (Lat. *to what damage*). A writ sued before the grant of certain liberties and franchises, as a fair, market, &c., which may be prejudicial to the king who grants, or the public; by it the sheriff is directed to inquire what damage may accrue from the grant in question.

Adactyle (Gr. ἀ, priv., and δάκτυλος, *a digit*). In Zoology, signifies a locomotive extremity without digits.

Adage (Lat. adagium, *a proverb*). The proverbs of antiquity are collected by Erasmus in a work entitled *Erasmi Adagia*. [PROVERB.]

Adagio (Ital. *leisurely*). In Music, a slow time.

Adamantine Spar. A variety of crystallized alumina, resembling the sapphire in composition, and of extreme hardness. The finest specimens come from India and China. At Bombay it is called Corundum.

Adamites. In Theology, a sect in the early ages of the Christian Church, who are said to have professed an exact imitation of the primitive state of innocence. They reappeared in the 15th century in Bohemia.

Adam's Peak, called Hamalell by the Singalese, and Al-rahoun by the Arabs. A mountain in Ceylon, chiefly noticeable from the veneration with which it has been regarded for ages by Brahmans, Buddhists, Chinese, Gnostics, and Mohammedans. The people make a grand pilgrimage to the summit once a year, and worship near the fabled print of the foot of Buddha. It was first called by the Portuguese the 'Pico de Adam.' (Tennent, *Ceylon*, vol. ii. pp. 132, 133.)

Adamsite. An ash-grey variety of Mica, found in small scales forming lamello-granular masses at Derby in Vermont.

Adansonia. A remarkable African tree, named after Adanson, a celebrated French botanist and traveller. It is called by the negroes *Baobab*. Miscalculations, founded upon the huge diameter of its trunk, have led to the belief that individuals may now exist some thousands of years old. [BAOBAB.]

Adapis. A name originally applied by Gesner to the hyrax or coney of Scripture, and adopted by Cuvier to designate another small pachydermatous, probably artiodactyle, quadruped, now extinct, but the existence and nature of which that great naturalist detected and deduced from three fragments of the head, which were discovered in that immense depository of fossil bones, the gypsum quarries of Montmartre.

The dentition of the *Adapis* is as follows:—each jaw has four trenchant incisors; two conical canine teeth, the upper ones straight, the lower inclined obliquely forwards; and apparently fourteen molar teeth, of which the first is trenchant, and the three or four posterior ones, on each side, like the posterior molars of the *Anoplotherium.* Cuvier supposes the animal to have been about the size of a rabbit, and to have closely approximated the Anoplotheria.

Adar (Heb. perhaps *fire*). The twelfth sacred and sixth civil month of the Jewish year. The leap year was the Veadar (or *second Adar*).

Adder. [VIPER.]

Addiction (Lat. addictio). In Roman Law, the making over of goods or slaves from one to another, by sale or legal sentence.

Addition. In Arithmetic, the first of the four fundamental operations, by which a number is found equal to several others taken together. In Algebra addition includes arithmetical subtraction; by its means several algebraical quantities are incorporated into one expression.

ADDITION. In Law, the personal description whereby a man is distinguished in *addition* to his name (gentleman, squire, and so forth).

Additive. Something to be added, in contradistinction to *subtractive*, which denotes something to be taken away. The terms additive and subtractive are sometimes applied to algebraic quantities. [POSITIVE QUANTITY and NEGATIVE QUANTITY.]

Addorsed (Lat. ad, *to*, and dorsum, *the back*). In Heraldry, that which is placed back to back.

Adductor (Lat. adduco, *I draw towards*). The adductor muscles are opposed to the abductors: they draw together the parts to which they are attached.

Adelphia (Gr. ἀδελφός, *a brother*). A collection of stamens into a bundle. Linnæus employed this term for those plants in which the stamens, instead of growing singly, combine into one or more parcels, or brotherhoods; thus, Monadelphia signified stamens all connected into one parcel, Diadelphia into two parcels, and so on.

Adelpholite (Gr. ἀδελφός, *a brother*, and λίθος, *a stone*). A niobate or tantalate of iron and manganese, with about ten per cent. of water, found at Rajamaki in Finland.

Adenography (Gr. ἀδήν, *a gland*, and γράφω, *I write*). In Anatomy, that which treats of the glands.

Adenostyleæ (Gr. ἀδήν, *a gland*, and στύλος, *a column* or *style*). A subdivision of composite plants, comprehending *Tussilago, Liatris, Eupatorium*, and some other genera, in which the branches of the style are covered with long glandular hairs.

Adephagans, Adephaga (Gr. ἀδηφάγος, *voracious*). A family of carnivorous and very voracious coleopterous insects.

Adept (Lat. adeptus, from adipiscor, *I obtain*). A distinctive term applied to those alchemists who were supposed to have attained the great object of their researches, or to have discovered the philosopher's stone.

Adhesion (Lat. adhæsio, from adhæreo, *I adhere*). In Botany, a property of vegetable matter by which contiguous parts grow together, and one of the causes of the great diversity of appearance in the organs of plants. Two opposite leaves grow together and form apparently one, through which the stem passes; several in a whorl adhere, and form an involucre; a number of petals adhere, and thus constitute a monopetalous corolla; several stamens adhere, and an adelphia is the result; some carpels contract an adhesion with one another, and form a compound fruit; finally, the calyx adheres to the sides of the ovary, and then seems as if it grew from the apex of it. Irregularity in flowers and fruit is also in many cases produced by the unequal manner in which adhesion takes place between similar parts; of the calyx, two of the sepals adhere into one parcel, and three into another, the result of which is a two-lipped calyx; the same thing occurs in the corolla and elsewhere.

ADHESION. In Physics, a term used to denote the force with which different bodies remain attached to each other, when they are brought into contact. The adhesion of solid bodies is exemplified in the force required to separate two pieces of glass or marble whose polished surfaces have been brought into contact. The elevation of water above its level in capillary tubes, or between two plates of glass very nearly in contact, shows the adhesion of a fluid to a solid body; and an instance of the adhesion of two liquids is obtained by covering a plate of glass with oil, and bringing it into contact with the surface of water; a very sensible force is required to raise it perpendicularly from the water.

The adhesion of the polished surfaces of solid bodies is proportional to the extent of the surface, or to the number of points brought into contact. It was formerly believed that the resistance to separation in this case arises solely from the pressure of the atmosphere; but the difference of its amount in different substances proves this opinion to be erroneous; besides, it is found to be the same in a vacuum. [CAPILLARY ATTRACTION.]

Adiantum (Gr. ἀδίαντος, *dry*). A genus of thin-leaved ferns, having their fructification in short marginal lines attached to the recurved portion. The leaflets are usually wedge-shaped and placed upon slender black shining petioles. *A. Capillus-veneris* was formerly employed in the manufacture of syrup of capillaire; it is slightly tonic and fragrant.

Adiaphorites (Gr. ἀδιάφορος, *indifferent*). A name given to Melancthon, and the party that agreed with him, in submitting, in things indifferent, to an imperial edict. The controversy which gave rise to this name had its origin in the imposition by Charles V., in 1548, of an edict styled the Interim, because it proposed to accommodate for a time the differences of the Papists and Protestants, until the whole matter

could be set at rest by the authority of a council. In the debate which followed there were two principal questions: first, whether it is lawful to yield to the enemies of truth, even in matters which are not of themselves essential; and, secondly, whether, granting the affirmative, the points in which the Interim required compliance, and in which Melancthon yielded it, are properly indifferent. Those points related chiefly to the doctrine of justification by faith, in which Luther and his genuine followers went to a great extreme; while Melancthon, although ostensibly the head of the Lutheran church, after the death of the great Reformer, adopted much more moderate views. Out of this controversy a great variety of other debates were engendered, and from these quarrels many schisms and divisions among Protestants derived their origin.

Adipic Acid. A solid fat resulting from the action of nitric acid on various oily matters.

Adipic Ether. A compound of adipic acid and ether. Its odour is that of rennet apples.

Adipocere (Lat. adeps and cera, *fat* and *wax*). A fatty substance produced by the decomposition of the flesh of animals in moist situations, or under water, resembling, in some of its properties, a mixture of fat and wax.

Adipose (Lat. adeps, *fat*). Unctuous, or containing fat. Adipose membrane is the cellular membrane in which fat is deposited.

Adit. In Mining, a level or tunnel driven either on a vein or bed, or through barren rock, nearly horizontal, but rising slightly as it proceeds, and always sloping sufficiently to enable water to run along it from the furthest point in the interior to the adit mouth. The principal drainage of every mine is carried on by the adit. In the early works of a mine, an adit of moderate length is preferred, so that the expense shall not be inordinately great. As the mine becomes more important, it is often worth while to drive another deeper adit through a much greater distance of rock, rather than lift the water ten, twenty, or thirty fathoms. This is a practical matter of great importance, depending on the quantity of water to be raised, and the probable cost of driving the adit, as well as on the prospects of the mine.

Adits are often made subservient to discovery in a mine, the course selected being such as shall cross the greatest possible number of lodes, and those believed to be most important. It thus becomes what is called a *cross cut.*

Sometimes the adit is driven upon a cross course or vein at right angles to the general direction of the right running veins.

In coal mining, where the beds are nearly level, the selection of an adit, if one be required and can be conveniently constructed, has little or nothing to do with discovery. In Cornwall and elsewhere a few great adits connect several mines, and are many miles in length.

Adjacent Angle. In Geometry, an angle immediately contiguous to another, so that one side and the vertex are common to both angles. The term is more particularly used when the two angles, besides having a common side, have their other sides in the same straight line. In this case, the adjacent angle is the same as the supplemental angle.

Adjective. In Grammar, that part of speech, denoting quality, which is annexed to nouns substantive to define more accurately the conceptions intended to be denoted by them. [GRAMMAR.]

Adjective Colours. Colours which require to be fixed by some base or mordant, in order to be applied as permanent dye-stuffs.

Adjournment (Fr. ajournement). In Parliamentary language, means a postponement of the sittings or proceedings of either House of Parliament, and differs from prorogation in this, that the latter is an act of royal authority, whereas the power of adjournment is vested in each house respectively, no definite limits being prescribed to it by the constitution. [PROROGATION.]

Adjudication (Lat. adjudicatio). In Bankruptcy Law is the act of the Court declaring the person to be bankrupt.

ADJUDICATION *special.* In Scotch Law, a mode of dealing with part of a debtor's lands, in the power of the Lords of Session.

ADJUDICATION *in implement.* Is a form of adjudication for the completion of defective titles to landed property.

Adjustment. In Marine Insurance, the settlement of a loss incurred by the insured.

Adjutage (Lat. adjuto). A term applied, by modern authors upon Hydraulics, to express the additional tubes added to the sides of an orifice in a vessel, for the purpose of obviating the resistance to the discharge by the contraction of the fluid vein. This resistance may become as great as 0·45 of the whole theoretical delivery of an orifice made in the bottom of a large sluice, and it is therefore a matter of great delicacy to determine the form of adjutage best fitted to obviate it. Venturi has made the most elaborate experiments upon the form of these tubes; and he arrived at the conclusion that it is best to make them of a divergent form, in which the dimensions of the orifice of delivery were about $0^{m}\cdot0338$, and the orifice at the entry $0^{m}\cdot0406$; the angle of the sides of the external tube was $5^{\circ}\cdot6$, and the length nine times the diameter of the effective opening. Venturi ascertained that the result of the application of these divergent adjutages was to increase the discharge by the orifice to about 1·46 times the theoretical discharge, and 2·4 times the discharge which would have taken place had the orifice been in a thin plate.

Adjutant. An officer appointed to each battalion of a regiment. His duty generally is to assist the commanding officer.

Adjutant-General. The chief staff officer of the army. His department is charged with the execution of all orders relating to the recruiting and equipment of the troops, their strength, instruction, and efficiency. There are also assistant and deputy-assistant adjutant-generals of divisions and districts.

Adjutant-General of the Jesuits. A title given to certain fathers who resided with the general of the order.

Adjuvant (Lat. adjuvare, *to help*). In Medicine, a substance which assists and promotes the operation of others.

Administration. In Law, if a person die intestate as to his personalty, letters of administration are granted by the ordinary [ECCLESIASTICAL COURTS] to such person as is pointed out by the statutes 31 E. 3, and 21 H. 8. These empower the ordinary to grant these letters to the widow, if there be one, or next of kin, at his discretion. Of persons equally near in degree, the ordinary may grant to which he please. If none of the kindred take out administration, a creditor may do it. When the will is made without the nomination of any executor, the ordinary grants administration cum testamento annexo. Where a person dies intestate, his personal property descends (subject to his debts) as directed by the statute of distributions, 22 & 23 C. 2, c. 10, explained by 29 C. 2, c. 30. One-third goes to the widow; the residue in equal proportions to the children, or, if they are dead, to their representatives, i. e. their lineal descendants. If there are none of these, then the widow takes a moiety, and the next of kin in equal degree, and their representatives, take the other; if there be no widow, they take the whole. But of representatives, none are admitted among collaterals, farther than the children of the intestate's brothers and sisters. The order of nearness of kin, with reference to the distribution of intestates' estates, is thus arranged according to the rules of the civil law—children, parents, brothers, grandfathers, uncles or nephews (and the females of each class respectively), and, lastly, cousins.

ADMINISTRATION. In Politics, in its general sense means the conduct or management of any affair; but in this country the term is usually applied to the management of the public or national affairs by the government, which is thence called *the Administration.*

Admiral (a word of doubtful origin). A great naval officer, who has the same power and authority over the maritime forces of a state that a general has over its land forces; and who also tries, or appoints officers to try, maritime cases. There are three ranks of Admirals, the Admiral (or full Admiral), Vice Admiral, and Rear Admiral. Each of these again has three gradations, of red, white, and blue, the colours of the flags they bear. The Admiral carries his flag at the main, the Vice at the fore, and the Rear at the mizen mast.

ADMIRAL, *Lord High.* The ninth great officer of state in England. The office has been usually given, at least since the reign of Henry IV., to some of the king's youngest sons, near kinsmen, or of the higher nobility. Since the reign of Charles II. it has been, with occasional exceptions, always in commission, and the commissioners are styled 'Lords of the Admiralty.' It was held by the late sovereign William IV., when Duke of Clarence, from 1827 to the following year.

Admiralty. The Board of Commissioners for executing the Office of Lord High Admiral, and having authority over naval affairs generally.

ADMIRALTY, *Court of.* In Law, is a court of record, of which the proceedings are principally carried on according to the course of the civil law; although, as the judge may have in some cases the assistance of a jury, it has also a resemblance to the courts of common law. It has jurisdiction principally for the determination of private injuries to private rights arising at sea, or intimately connected with maritime subjects; and in most cases to which its authority extends it has concurrent jurisdiction, either with the common law courts, or those of equity. Suits may be instituted in this court for assault and battery at sea; for collision of ships; for the restitution of goods piratically taken not under colour of war. It has also an equitable jurisdiction between part owners of a ship. It adjudicates in suits for mariners' wages, and for pilotage. It has a peculiar jurisdiction in cases of bottomry bonds, and other deeds in the nature of a mortgage of the ship; having an exclusive power to grant warrants to arrest the ship itself. It has also jurisdiction in cases of salvage, and incidentally of wreck. See the Act 24 Vict. c. 10 (1861) to extend the jurisdiction and amend the practice of this court.

The prize court, which decides prize causes in time of war, is a separate tribunal, although usually presided over by the same judge as that of admiralty.

Admission (Lat. admissio). In Law, that which a party, in pleading, admits against himself, and thereby relieves the adversary from the necessity of proving. Such an admission, technically styled 'on the record,' may be either actual or constructive. It is common to speak also of admissions made by agreement between the parties.

Admonition (Lat. admonitio). The first step of Ecclesiastical censure, which always precedes excommunication. (Hook, *Church Dictionary*, s. v.)

Admonitionists. Certain Puritans, who in 1571 sent an 'admonition' to the Parliament, condemning everything in the Church of England which was not in agreement with the doctrine and practice of Geneva. (Hook, *Church Dictionary*, s. v.)

Adnate (Lat. adnatus, from adnascor, *I grow to anything*). An organ is said to be adnate when it grows to the face of another, and not to its apex, in which latter case it would be innate. The term is chiefly employed in botany in speaking of anthers.

Adonic (Gr. Ἄδωνις). A verse consisting of a dactyl and a spondee, as in the last line of every Sapphic Stanza, as, *visere montes*, Horace, *Od.* i. 2.

Adonis. (Gr.) In Mythology, a beautiful youth beloved by Aphrodite or Venus, and slain by a wild boar, or, according to other versions,

by Apollo or Artemis. Adonis is the father of Priapus, and is identified with the Eastern Thammuz. A river of the same name in Phœnicia was supposed yearly to express its sympathy for his death by changing the colour of its waters to red. (Milton, *Paradise Lost*, i. 415.)

Adopter. A vessel with two necks placed between a retort and a receiver, serving to increase the length of the neck of the former.

Adoptians. In Ecclesiastical History, the name given to the followers of Elipand, Archbishop of Toledo, and Felix, Bishop of Urgel in Spain, who maintained, that, as to his humanity, Christ was only the adopted Son of the Father. (Milman, *History of Latin Christianity*, book v. ch. i.)

Adoption (Lat. adoptio). In the Civil Law, signifies the admission of a stranger to the rights and privileges of a son. Adoption was a common custom among the Romans, by whose law a relation, nearly resembling that of master and slave, was constituted between father and son; so that a child, adopted from one family into another, passed, in effect, from the power of his parent to that of his adopter. Adoption is said, in Justinian's Institutes, to be of two sorts: the one, also called arrogation, where a person, independent of parental control, is adopted into a family by virtue of an imperial rescript; the other, where, by the authority of a magistrate, a child passes from one family to another. But unless the adopter possessed a certain right by blood over the person adopted (as a grandfather), the parental power of the father was not extinguished. Adoption exists in the jurisprudence of various countries, where derived from the civil law; as in the German states and in France. In the latter country, the person adopting must be one having neither children nor other legitimate descendants.

Adoration (Lat. adoratio). This word, derived by many from the expression *ad os* (to carry the hand to the mouth), was applied originally to religious ceremonies, in which the worshipper kissed his hand and then held it out towards the statue of the god whom he was reverencing. It was afterwards used to signify prostration before kings, a custom apparently Persian in its origin. The attempt of Alexander the Great to exact it from his officers caused great dissatisfaction. It was introduced into the Roman court by Diocletian, and the practice was afterwards regulated by an elaborate ceremonial. (Gibbon, *Roman Empire*, ch. liii.)

Also a term used for a mode of electing a pope. The cardinals rush hastily, as if by an internal impulse, and proclaim some one pope.

Adpressed. In Botany, when one part lies close to another throughout its length, as hairs to the surface of a leaf. The same as APPRESSED.

Adragant. Gum Tragacanth.

Adrianople Red. A term applied by dyers to the red obtained from madder: it is also called *Turkey red*.

Adrift. Not fastened; as a ship that has parted from her anchor, a boat that has broke from her ship, a gun from the ship's side, &c.

Adularia. A transparent or translucent variety of Orthoclase or potash-felspar, which is found in colourless crystals, with a strong vitreous lustre, at St. Gothard in Switzerland; the finest specimens being procured from one of the highest peaks, called Adula: whence the name Adularia. It is also met with in the United Kingdom in the slate of Tintagel in Cornwall; on Snowdon with quartz; in the Isle of Arran in Buteshire; and on Slieve Corra, one of the Mourne mountains, in Ireland. It is sometimes used as a glaze for the finer kinds of pottery.

Adulteration (Lat. adulteratio). The partial substitution of inferior, cheaper, useless, or other undesirable material, for professedly genuine merchantable articles. Individual greed has always been an incentive to the practice of adulteration by traders, but of late years the public demand for cheap goods, and the competitive supply occasioned by it, has greatly contributed to increase this practice. The adulteration of tobacco, beer, tea, coffee, bread, and a few other articles of general consumption, has for some time been punishable by law. But although by the aid of the chemist and microscopist, it is generally an easy matter to detect adulteration, it is difficult to prove by whom the sophistication has been practised; convictions, consequently, have seldom been effected. The same obstacle to successful legislation in the matter has also been one of the chief causes of the failure of the 'act for preventing the adulteration of articles of food and drink,' which was passed in 1860: moreover adulteration is still allowed, provided the sophisticated material be neither injurious to health, nor stamped or warranted 'genuine.'

Adulterine. In Law, properly the children begotten by adultery of the father or mother, who were excepted by various laws and usages from that legitimation of natural children which in the civil law takes place by subsequent marriage.

Adulterine Guilds. Persons acting as a trading corporation without a charter, and paying a fine annually for permission to exercise their usurped privileges. (Smith, *Wealth of Nations*, b. i. c. 10.)

Adultery (Lat. adulterium, a word of very uncertain derivation). The sin of incontinence committed by a married person: adultery between two married persons is termed *double* by some jurists. By the law of Moses, adultery was punished by death, Lev. xx. 10, Deut. xxii. 22; and passages in Proverbs (c. vi.) and Ezekiel (xvi. 38, 40) prove that the law was observed in this respect down to the overthrow of the Jewish monarchy, as we know it to have been in the time of our Saviour. The mode of punishment was by stoning; but it is observable that this mode is not ordained in Deuter-

onomy, as it is for various other offences. The test or ordeal of adultery is detailed in Numbers v. 11 – 31. Under the Grecian and Roman republics adultery was variously treated; but the celebrated Lex Julia de Adulterio, under Augustus, punished it with banishment (deportatio vel relegatio).—Tacit. lib. ii. *Annal.* It was not until the reign of Constantine, when some tincture of Judaism had been introduced into the state, along with the establishment of Christianity, that the punishment of death was formally enacted for it. This penalty was again mitigated under Leo and Marcian; and by the laws of Justinian the adulterer was punishable with death, the adulteress with flagellation, imprisonment, &c. But about the same period the gradual increase of episcopal authority in civil cases, seems to have drawn crimes of incontinence almost wholly within the cognisance of the ecclesiastical courts; and the canons contain a variety of directions on the subject of adultery. On the other hand, the jurisprudence of the Northern nations, which visited this as well as other crimes of freemen with very little severity, as mere offences against individuals, reduced the penalty in most of the Western kingdoms to a mere pecuniary one, sometimes attended with public disgrace or corporal punishment. Such penalties fell rapidly into disuse; and in the sixteenth century we find it observed by a French civilian (quoted by Thuanus), that 'it was never heard that anybody had been punished for adultery in France.' This observation is quoted by the historian when relating an event which created great sensation at the time, namely the capital punishment at Orleans of two offenders by St. Cyr, the governor, a rigid Calvinist. The protestants of that sect, in France as well as in Scotland and England, made it their endeavour to introduce primitive severity of manners by severity of punishment. De Thou appears also to have made some efforts toward putting in force the laws against adultery: but from the time of the religious wars, penal cognisance of adultery may be said to have nearly ceased in France, although, by various arrêts (1637, 1701, &c.), besides the civil consequences of an action of adultery by husband against wife, the latter might be condemned to seclusion in a house of correction for two years, or more; and the punishment of imprisonment still subsists, and has been in some recent cases inflicted. In Geneva, Strasburg, and other places where the reformed religion prevailed, a temporary strictness of law was introduced about the same period, but with little permanent effect. In England, by the old common law, mutilation was the punishment of this as well as other offences; but under the Plantagenets it became matter of ecclesiastical cognisance (except so far as civil consequences were concerned), and visited only by the spiritual censure of the church. 'The rules of the canon law,' says a recent writer, 'have manifested an indulgence towards this offence which is chiefly to be accounted for by reference to the constrained celibacy of its early compilers.' But in 1650 the Puritans, under Cromwell, succeeded in obtaining an ordinance by which adultery, as well as simple fornication, was made felony, without benefit of clergy; an absurd decree, which was soon repealed. [For the civil consequences of Adultery, *see* DIVORCE; MARRIAGE, LAW OF.]

Advent (Lat. adventus). The holy season, comprising four Sundays before Christmas. It begins on St. Andrew's day, the 30th of November, or on the Sunday next before or after it, according to the day of the week on which the 25th of December falls.

Adventitious (Lat. adventitius, *foreign* or *strange*; hence, *extraordinary*). In Botany, when anything appears out of the ordinary course of nature: if a bud appears where buds do not usually appear, it is adventitious. This term must not be confounded with abnormal, which is used when anything is *constructed* out of the ordinary course.

Adverb. A word annexed to an adjective or verb, to define more closely the modifications of the quality or action denoted. [GRAMMAR.]

Adversa (Lat). A medallic term, applied to two heads facing each other.

Adversaria (Lat). In Philology, a classical title used for books of miscellaneous remarks or discussions.

Adverse (Lat. ad, *to*, and verto, *I turn*). In Botany, leaves are so called when they present their under-surface to the sun.

Advertisement (Lat. adverto, *I attend to*). In its general sense, means any information as to any fact or circumstance. But it is more particularly used to designate notices made by competent authority in the daily papers, and otherwise, of events of local or general interest, as the publication of new books, sales of estates and produce, meetings of creditors, formation and dissolution of partnerships, &c. Such notices, when inserted in the *Gazette*, or in newspapers and literary works published in numbers, formerly paid a duty, which was abolished by an act passed in 1853.

Advocate (Lat. advocatus, *he who is called in to plead in a court of law the cause of another*). The original pleaders of causes at Rome were the patricians, who defended their clients gratuitously; but even before the downfall of the republic, the class had degenerated into a profession, (its members receiving rewards for their services,) although still among the most honourable of employments. But from the original gratuitous character of advocates arose the peculiar custom by which, among ourselves, the fees of barristers are still regarded as honorary, and cannot be recovered at law. In the later ages of the empire the advocati appear to have formed a distinct class from the jurisconsulti, or chamber-counsel, and to have much declined in reputation. In France the avocats, or counsel, form a separate order, of which each member is attached to a particular local court. The Lord Advocate, in Scotland, is a public officer, who prosecutes

crimes before the court of justiciary. The Queen's Advocate, in England, conducts the business of the crown in the Ecclesiastical and Admiralty Courts, and has precedence of the Attorney- and Solicitor-General. The Judge-Advocate acts for the prosecution in courts-martial, and is the military law adviser of the crown.

Advocates, Faculty of. The bar of Scotland in Edinburgh is so called.

Advowson (Lat. advocatio, *a calling*). Properly the relation in which a patron (advocatus) stands towards the living to which he presents, i. e. the patronage of a church. The earliest provision for divine worship, in England and in other countries, was derived from the offerings of the laity, which were distributed by the bishop of each diocese among his clergy, whom he sent from place to place to preach and administer the sacraments. By degrees he was enabled, by the bequests of the faithful, and the customary offering of tithes, to subdivide his diocese, or parochia, as it was originally called, into various districts, and to build churches and establish permanent ministers in each. At the same time it became a common practice among the nobles to build and endow churches for the benefit of themselves and their own dependants; in which case they were allowed to present to the benefice, subject to the licensing power of the bishop and the canons of the church. Advowsons, in legal phraseology, are either appendant, where immemorially annexed to a manor; or in gross, where they form separate subjects of property. If the patron of a rectory fails to present within six months after the vacancy happens, the right falls to the bishop, and by similar neglect on his part, to the archbishop, and thence to the king. The presentation is by letter to the bishop; institution, by an instrument registered in the bishop's court; and induction, which completes the incumbent's title, is performed by the archdeacon.

Ady. A palm tree growing on the Island of Thomé, on the coast of Malabar. The aromatic kernel of its fruit contains an oil from which a kind of butter is made.

Adytum (Gr. ἄδυτον, from ἀ, neg., and δύω, *to enter*). The shrine, or holy of holies, in temples where oracles were given or where the worship was connected with mysteries. To this shrine only priests had access. The *secos* of the Egyptian temples seems to have answered to the adytum of the Latins. The Greeks introduced into their religious edifices a treasure chamber, or *opisthodomos*, which had its entrance in the back-front of the temple. The adytum of the small temple of Pompeii is one of the best preserved examples of these chambers. It is raised some steps above the level of the body of the temple and is without light.

Adze. A carpenter's tool, used as an axe, but of which the blade is made curved, and with its edge, not like the axe, parallel to the handle, but placed at right angles to it. The adze is used to dress timbers in such situations as the plane will not reach with any advantage, especially in dressing the posts, &c., in ship building, and in floors, &c.

Æchmalotarch (Gr. αἰχμάλωτος, *taken with the spear*, and ἄρχω, *I rule*). The title of the governor of the captive Jews residing in Chaldea, Assyria, and the adjacent countries. He was called by the Jews themselves *Rosch-galuth*, chief of the captivity.

Ædelforsite. A neutral silicate of lime, occurring massive, and fibrous or feathery, of a white or greyish colour, at Ædelfors in Sweden. The name Ædelforsite has also been given by Retzius and Nicol to the red zeolite of Ædelfors. [Retzite.]

Ædes. The Latin term for a dwelling of any kind, but more especially applied to large town dwellings, or palaces, in contradistinction to *domus*, a small private dwelling, or to *villa*, a country house. The small temples dedicated to the service of the gods by the piety of private individuals, and which were not consecrated by the augurs, were also called *ædes*, and were so far from being considered sacred edifices that they were frequently devoted to profane uses, as in the case of the Ædes Saturnii, which was made to serve as the Ærarium. In the later periods of the Roman Empire this distinction between the *ædes* and the *templum* was lost sight of; and at all times the form and distribution of the two classes of monuments were analogous.

Ædicula (Lat). In the singular, a room; in the plural, a small house; at other times, a small temple. In the latter sense it is applied to the shrines for the reception of the statues of the deity, as for instance, in the *ædicula* of the Pantheon of Rome, or to the domestic shrines in which were placed the statues of the Lares, Penates, or the protecting divinities of the house or city, ranged round the courts of the ædes.

Ædile. The title of certain Roman magistrates, so called from their care of buildings (*ædes*). They were divided into two classes, distinguished by the epithets plebeian and curule. The two plebeian ædiles were, as their name imports, elected from the commonalty (*plebs*), and were subordinate to the tribunes of the commons, having jurisdiction over lesser causes, submitted to them by those magistrates. The two curule ædiles, so called from their privilege of giving judgment on ivory seats (*sellæ curules*), were originally elected from the patricians, but afterwards from both plebeians and patricians promiscuously. This magistracy was one of the most dignified in the state, and was allowed the use of the robe of honour (*toga prætexta*), and a certain precedence in the senate. The peculiar office of the ædiles was the superintendence of public works, markets, &c., in the city. They had also, particularly the curule ædiles, to exhibit public games, which they often did at a vast expense, in order to court popularity. Julius Cæsar added two plebeian ædiles, called Cereal, to inspect the public stores of provisions. (Smith, *Dictionary of*

Greek and Roman Antiquities, s.v. For the doubtful points connected with the origin of these offices, see Sir G. C. Lewis, *On the Credibility of Early Roman History*, ch. xii. xiii.)

Ægiceræ (Gr. αἴξ, *goat*, κέρας, *horn*). A division of Myrsinaceous plants, the type of which is the genus *Ægiceras*. It is distinguished by the absence of albumen; the species grow in maritime swamps in tropical countries, and have the embryo germinating within the pericarp, after the manner of mangroves.

Ægilops (Gr. αἴξ, *a goat*, and ὤψ, *an eye*). A sore in the inner angle of the eye, frequently terminating in fistula lachrymalis. Goats were supposed to be very subject to this affection.

ÆGILOPS. A genus of grasses, which there is reason to suppose may have been once the mother of wheat.

Ægirine. A black or greenish variety of Pyroxene, allied to Arfvedsonite, found at Brevig, in Norway.

Ægis (Gr. αἰγίς). The mythological shield of Zeus (or Jupiter), which was covered with the skin of the goat Amalthæa, and given by him to Athena (or Minerva), who, by fixing on it the head of Medusa, gave it the power of petrifying all persons who looked at it. In some works of art it is represented as a metal breastpiece, wrought in scales.

Ægle (Gr. Αἴγλη, *one of the Hesperides*). A genus of the orange family, containing the bhel fruit, *Æ. Marmelos*, which is of exquisite flavour. The rind furnishes a yellow dye, and in the unripe state possesses astringent properties, on which account it is used in India in cases of dysentery. The genus is known from that of the orange by the stamens being separate, not united in bundles.

Æneid. The epic poem of Virgil, relating the wanderings of Æneas after the capture of Troy, and his settlement in Italy.

Æolipile (Lat. Æolus, *the god of the winds*, and pila, *a ball*). An hydraulic instrument, contrived for the purpose of exhibiting the convertibility of water into steam. It consists of a hollow ball of metal, having a slender neck or pipe, with a very small orifice inserted into it. The ball, having been filled with water, is placed over the fire, and the heat gradually converts the water into vapour, which rushes out of the pipe with great violence till the whole is discharged. The experiment is not unattended by danger, for should the small orifice by any accident be stopped, the steam would burst the ball. The æolipile was known to the ancients, being mentioned by Vitruvius. Descartes and others have used it to account for the natural cause and production of the wind; hence its name, Æolipile. The æolipile is sometimes filled with alcohol, and the jet of its vapour being inflamed, it serves the purpose of a blowpipe.

Æolus. In Mythology, the god of the winds, who was fabled by the early poets to have his seat in the floating island of Æolia; but the Latin and later Greek poets placed him in the Lipari isles. Here the winds were pent up in vast caves, and let loose or restrained by Æolus at the bidding of Jupiter. See a fine passage in Virgil, *Æneid*, i. 52.

Æolus' Harp, or **Æolian Harp.** An instrument, which produces a pleasing combination of sounds by the action of the wind. Its construction is very simple, consisting of merely a number of catgut or wire strings, stretched in parallel lines over a box of thin deal, with sounding holes cut in the top. The strings being tuned in unison, the effect is produced by placing the instrument in a current of air. The invention of the Æolian harp is generally given to Kircher, by whom it was first described.

Æon. [GNOSTICS.]

Æpyornis (αἰπύς, *high*, and ὄρνις, *bird*). A colossal genus of cursorial birds, which has left its remains in pliocene strata in Madagascar. One of the fossil eggs of this species has been estimated to contain as much as six ostrich eggs, or 148 hens' eggs.

Æra, or **Era** (Lat.). In Chronology, the term æra denotes the account of time reckoned from some particular date or epoch, chosen for the commencement of the æra.—Thus the Christian æra began at the birth of Christ; the Mohammedan æra at the flight of Mohammed from Mecca to Medina; the æra of Diocletian at the coronation of that emperor, &c.; and the period of the occurrence of any event is ascertained by reckoning from one or other of these epochs. When, for example, it is said, that Queen Victoria ascended the throne of Great Britain in 1837, it is meant that this event took place in the 1837th year of the Christian æra, or of that æra which began with the birth of Christ. It is plain that the epoch, or point of time selected for the commencement of an æra, is necessarily arbitrary; and different nations have adopted different epochs coincident with some important event in their civil or religious history. Some chronologers reckon from the creation of the world; and this event, were its date well ascertained, would be the best epoch that could be selected. The Greeks used to reckon by the æra of the Olympiad [which see] which began at the summer solstice, anno 776 B.C. The Romans reckoned from the building of the city, generally held to be April 24th, B.C. 753. The Julian æra dates from the reformation of the calendar by Julius Cæsar, B.C. 45. All Christian nations now adopt for their æra the birth of Christ, supposed to have taken place in the middle of the fourth year of the 194th Olympiad, and the 753rd year of the building of Rome. The æra of most Mohammedan nations is that of the Hegira, or flight of Mohammed to Medina, corresponding with July 16th, A.D. 622. The æra of Sulwanah, in common use in a great part of India, corresponds to A.D. 78. The æra of Yezdegird, used in Persia, began June 16th, A.D. 632.

Subjoined are the names of some of the principal æras, with the year of the Christian æra in which they began, and the abbreviations by which they are commonly distinguished.

	Commenced	Abbreviations
Year of the World: —		
Constantinopolitan account	B.C. 5509	A.M. Const.
Alexandrian account . .	5492	A.M. Alex.
Jewish account	3760	A.M.
Era of Nabonassar . . .	747	Er. Nab.
Olympiads	776	Olymp.
Year of Rome	753	A.U.C.
Julian Æra	45	Jul. Ær.
Christian Æra	—	A.D.
Æra of Salwanah	A.D. 78	Saca.
Æra of Diocletian	284	Ær. Dioc.
The Hegira	622	A.H.
Æra of Yezdegird	632	Æ. Pers.

The term *æra* is frequently used as synonymous with *epoch*, but it would seem incorrectly. (Scaliger, *De Emendatione Temporum.*)

Ærarian. The term applied to a Roman citizen who had been degraded to the lowest rank compatible with personal freedom, and who had become, therefore, a mere payer of money (*æs, æris*) for the support of the state. He still paid taxes, but enjoyed no privileges, and could not serve in the army, or, consequently, participate in the distribution of land granted to such classes as did.

Ærarium (Lat.) The public treasury of the Roman plebs, the care of which was vested in the quæstors. After the fall of the republic the ærarium was kept distinct from the treasury of the emperor, which was called fiscus. The ærarium sanctius, or more sacred treasury, was appointed to provide for cases of extreme emergency, and might not be opened on other occasions.

Aërated Waters. Waters charged with gas under pressure. The gas is usually carbonic acid, derived from bicarbonate of soda or from carbonate of lime by the action of a dilute acid. Aërated waters commonly contain dissolved salts, and are then termed *mineral waters*. All natural water is more or less aërated, and the flat mawkish taste of recently boiled water is due to the absence of dissolved carbonic acid and of atmospheric air. The term is, however, commonly restricted to water artificially charged with gas, and which on exposure to the ordinary pressure gives off a part of its gas with effervescence. Wine and beer are rendered 'sparkling,' or effervescent, by internal decomposition after bottling.

Aërial (Gr. ἀήρ, *air*). In Painting, a term applied to the diminishing intensity of colour on objects receding from the eye. Aërial perspective is the relative apparent recession of objects from the foreground, owing to the quantity of air interposed between them and the spectator, and must accompany the recession of the perspective lines.

The degree of aërial gradation required depends upon climate and the time of day, the effects varying with the degrees of moisture in the atmosphere. It is scarcely indicated in the backgrounds of the early Italian painters.

Aërial Acid. [Carbonic Acid.]

Aërial Images. In Optics, the name given to images of objects produced by reflection or refraction when they appear suspended in the air. For example, a spectator standing before a concave mirror, at a somewhat greater distance from it than its radius of curvature, sees an inverted image of himself, hanging as it were between him and the mirror. For examples of aërial images produced by refraction, see Fata Morgana; Mirage.

Aërial Plants, or Aerophytes (Gr. ἀήρ, and φυτόν, *a plant*). Plants which grow in air only, as distinguished from terrestrial plants or those which grow in earth. The epiphytal orchids, and many lichens, are aërial plants, deriving sustenance from atmospheric moisture. They are to be distinguished from parasites, like mistleto, which feed on and not merely grow on trees, &c.

Aëro-dynamics (Gr. ἀήρ, and δύναμις, *power*). The science which treats of the motion of the air, and of the mechanical effects of air in motion. This is a branch of experimental science, and there are two ways in which it may be investigated. The first consists in ascertaining the effects which air moving with a certain velocity, that is, wind, produces on a body against which it strikes; and the second, in measuring the resistance which air at rest offers to a solid body passing rapidly through it. The problem is exactly the same, whether the body is considered as moving against the air at rest, or the air is supposed to move against the body with the same velocity.

When a solid body is moved out of its position, the space which it occupied is not filled with air instantaneously, but only after a sensible, though very short time. Theory, confirmed to a certain degree by experience, shows that air, under the ordinary atmospheric pressure, rushes into a vacuum with a velocity of between 1300 and 1400 feet in a second of time.

Now, conceive a body, for example a cannon ball, to be moving rapidly through the air, but with a less velocity than 1300 feet per second. The air in front of the ball will remain in its natural state, because the condensation produced every instant by the contact of the ball, is propagated more quickly than the ball moves (the velocity of the propagation being equal to that with which air enters a vacuum). But there is a certain space behind the ball in which the air has not entirely recovered its equilibrium, but remains more or less rarefied, the ball having passed through it in less time than is required for the surrounding air entirely to fill it. In addition, therefore, to the resistance which arises from the communication of motion to the particles of air, an effect proportional to the square of the velocity, there is a pressure on the front part of the ball, not counterbalanced from behind; in consequence of which, we may infer that the resistance will increase in a quicker ratio, and this deduction is confirmed by practical experience.

The resistance of the air on the motion of projectiles was first examined experimentally by M. Robins (see his *Principles of Gunnery*),

and afterwards by Dr. Hutton, of Woolwich (see his Tracts, vol. iii., and *Math. Dictionary*). [Projectiles; Wind.]

Aërolite (Gr. ἀήρ, *air*, and λίθος, *a stone*). The origin of these singular substances is involved in the greatest mystery. Some philosophers, among whom is Laplace, the illustrious author of the *Mécanique Céleste*, suppose them to be ejected from volcanos in the moon; others suppose them to exist ready formed in the celestial space, circulating about the sun with great velocity, like planets, and falling to the earth when its attraction upon them preponderates; others regard them as fragments of rocks which have been propelled by terrestrial volcanos to an immense height above the limits of the atmosphere, and again descend after having described several revolutions about the earth.

On examining and comparing aërolites, the first circumstance that strikes us as remarkable is their resemblance to one another in their composition, whatever be their form or magnitude. Their exterior surface is black, as if they had been exposed to the heat of a furnace. Internally they are of a greyish white. Their specific gravity varies between 3·352 and 4·281. Their chemical analysis gives, in almost every instance, the same substances, combined in nearly the same proportions. They are composed of silica, magnesia, sulphur, iron in the metallic state, nickel, and some traces of chrome. Sometimes they are of a spongy or cellular texture, the cavities being filled with a stony substance. They have occasionally been found without nickel. These common and constant characters indicate a common origin, and their composition renders it probable that it is to be sought elsewhere than in the earth. Iron is scarcely ever found (if, indeed, at all) in the metallic state in terrestrial substances; volcanic matter contains it only in the state of oxide. Nickel and chromium are also rare, and not found on the surface of the earth.

The fall of the aërolites is accompanied by meteors, named bolides, or fire balls. They are, in fact, inflamed globes, which appear instantaneously in the atmosphere, and move through it with extreme velocity, sometimes even equal to that of the earth in its orbit. The direction of their motion is inclined to the horizon. After shining with great splendour for a few instants, they explode with a loud noise, and often at a great height, thirty or forty miles above the surface of the earth. They do not affect any peculiar direction with respect to the motion of the earth, but seem to come from all points of the heavens indifferently.

With regard to the hypothesis which explains the origin of the aërolites, by supposing them to be propelled from lunar volcanos, it may be remarked that no improbable amount of mechanical force would be required. As there is no atmosphere about the moon sufficient to offer a sensible resistance to the motion of a solid body, the force required is only that which would be sufficient to overcome the moon's attraction, which is found by calculation to be about four times the force with which a ball is expelled from a cannon with the ordinary charge of gunpowder. A body projected with a velocity of about 7770 feet per second from the lunar surface would be detached from the moon, and be brought to the earth by terrestrial gravitation. But philosophers seem now disposed to assign the aërolites a different origin. From the phenomena of comets there is reason to believe that portions of chaotic matter are dispersed in the planetary regions in detached parcels, or perhaps in considerable masses. The earth in describing its orbit may meet with such masses directly, or pass so near to them as to carry them along with it by virtue of its attraction. On plunging into the atmosphere with the velocity due to the height from which they have fallen, which is that of their distance from the earth when they begin to obey its attractive force, an enormous heat is evolved by the rapid and powerful condensation of the air; the matter becomes inflamed, and the aërolite is the product of the combustion. In the same manner shooting stars, and other igneous meteors of frequent occurrence, are explained. The chaotic matter may be entirely consumed long before it reaches the earth, in which case the appearance of the bolide will not be accompanied with the fall of an aërolite. [Fireballs; Meteorite.]

Philosophers were long inclined to disbelieve in the fall of stones through the atmosphere. The fact, however, is now placed beyond all doubt by numerous and well-authenticated instances which have occurred in almost all quarters of the world, even within the present century. A very complete list of the falls of stony or earthy matters, with the times and places of their occurrence, and the appearances they exhibited, is published in the *Edinburgh Philosophical Journal*, from a work by Chladni, in German, in which the whole subject of meteoric stones is ably and fully treated.

Aërology (Gr. ἀήρ, and λόγος, *a discourse*). The doctrine of air, generally applied to medical discussions respecting its salubrity.

Aërometer (Gr. ἀήρ, and μέτρον, *a measure*). An instrument for making the necessary corrections in pneumatic experiments, to ascertain the mean bulk of gases.

Aëronautics (Gr. ἀήρ, and ναυτικός, *of or belonging to ships*). The art of sailing in and navigating the air. [Balloon.]

Aërophytes (Gr. ἀήρ, and φυτόν, *a plant*). Plants which live exclusively in air; in distinction to hydrophytes, which live as constantly under water.

Aërostatics (Gr. ἀήρ, and στατική, (sc. ἐπιστήμη), *the science which determines the properties of bodies at rest*). A term sometimes used to denote the science which treats of the equilibrium of elastic fluids. [Pneumatics.]

Aërostation. Means simply the weighing of the air; but is sometimes employed in the same sense as aëronautics.

Æschynite (Gr. αἰσχύνη, *disgrace*). A titanate of zirconia and cerium, found in Felspar, in the Ilmen range of mountains, near Miask in Siberia. It occurs in oblique rhombic prisms, terminated by four-sided pyramids, which are generally striated and imperfect. The crystals are nearly black and opaque, or inclining to brownish-yellow when translucent. The name was given by Berzelius, in allusion to the inability of chemists, at the time of the discovery of the mineral, to separate the titanic acid and zirconia which enter into its composition.

Æsculaceæ. A natural order of exogenous plants, consisting of the horse-chestnut, *Æsculus hippocastanum*, and other nearly allied species. They are all either shrubs or trees inhabiting temperate regions, and nearly correspond with the horse-chestnut in the structure of the flowers. Their seeds contain starch mixed with the detergent matter called saponine, and their bark is in some cases bitter and astringent.

Æsculapius (Gr. Ἀσκληπιός). In Mythology. He was the son of Apollo and the nymph Coronis. He was worshipped as the god of surgery and medicine; but the older poets, as Homer and Pindar, mention him only as a hero well skilled in these arts. The chief seat of his worship was Epidaurus, where he was represented as an old man, with a mantle and staff, round which a serpent is twined.

Æsculine. A peculiar substance contained in the bark of the horse-chestnut tree (*Æsculus hippocastanum*): it appears in the form of a white crystalline powder, and when dissolved in very minute quantities in water, communicates a blue opalescence to it.

Æsthetic (Gr. αἰσθητικός, *having the power of perception by means of the senses*). In the Fine Arts, that which derives the first principles in all the arts from the effect which certain combinations have on the mind, as connected with nature. The æsthetic quality of a work of art is that which is apprehended by the perceptions or feeling, irrespective of the understanding.

Æsthna. A name applied by Fabricius to a genus of dragon-flies, characterised by having the wings expanded when at rest, and the divisions of the lip equal.

Æstivation (Lat. æstivus, *of or belonging to summer*). A figurative expression, employed to indicate the manner in which the parts of a flower are arranged before they unfold. Botanists speak of the æstivation of the calyx, of the corolla, and of the stamens.

Æstuary, or **Estuary** (Lat. æstuarium). In Geography, was anciently understood to be any creek, frith, or arm of the sea, in which the tide ebbs and flows (Plin. *Epist.* lib. ix, ep. 33); but it is now applied to designate those parts of the channels of certain rivers contiguous to the sea, in which the water is either salt or brackish, and in which the ebb and flow of the sea is distinctly perceptible, and there is little or no current.

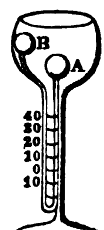
Æsymnetæ (Gr. αἰσυμνῆται). A class of Greek tyrants, who acquired their power from having been invested by the citizens with supreme authority, and placed in command of the military force, but only for a given time, and to deal with some definite emergency, but who became practically despots for life. (Grote, *History of Greece*, part ii. ch. ix.)

Aëtheogamous (Gr. ἀήθης, *unusual*, and γάμος, *marriage*). A name contrived to express more clearly the nature of what are called Cryptogamic plants; it being the opinion of the author of the name that the mode of propagation among such plants was not hidden, but only of an unusual nature. It has been confined by De Candolle to such as have vessels, as well as cellular tissue, in their organisation. In this sense it includes ferns, lycopodiums, and their allies.

Æther. [ETHER.]

Æthogen (Gr. αἴθων, *brilliant*, γίγνομαι, *I become*). A compound of nitrogen with boron, remarkable for the intense luminosity which it exhibits in the flame of the blowpipe.

Æthrioscope (Gr. αἴθριος, *clear*, and σκοπέω, *I view*). An instrument invented by Sir John Leslie for measuring the relative degrees of cold produced by the pulsations from a clear sky. It consists of a differential thermometer, adapted to the cavity of a spheroidal cup of metal, the interior of which is highly polished, in such a manner that one of the balls occupies a focus of the spheroid; while the orifice of the cup is formed by a plane passing through the other focus, perpendicular to the axis. A lid of the same metal is fitted to the mouth of the cup, and only removed when an observation is to be made. Suppose the cup exposed to a clear sky; the cold pulses darted from the upper regions of the atmosphere, which enter the orifice of the cup, are reflected from the polished surface upon the ball A in the focus, while the ball B, lodged at the side of the cup in its widest part, is nearly screened from them, or receives only the small number which fall obliquely upon it. The two balls are thus exposed to different degrees of cold, the effect of which is immediately apparent, by the rise of the liquor in the stem of the thermometer, in consequence of the contraction of the air in the ball A. The effect may be augmented by covering the ball B, which is out of the focus, with a coat of gold or silver leaf. It is evident that the instrument is equally adapted to measure the effects of the radiation of heat, which will be manifested by the descent of the liquor in the stem. When applied to this purpose, however, the metallic cup becomes unnecessary; the hot pulses being mostly thrown back from the bright surface of the gilt ball, while they produce their full effect on the naked or sentient one. The æthrioscope is thus converted into a pyroscope. (*Encyc. Brit.*, art. CLIMATE.)



Æthusa (Gr. αἴθουσα, part. of αἴθω, *I burn*).

A genus of the Umbelliferous family, containing one common species, a weed in most cultivated ground. This plant, *Æ. Cynapium*, or fool's parsley, is an acrid poison, and from its resemblance to common plain-leaved parsley should be carefully discriminated. When in flower it is readily known by the presence of a few deflexed narrow involucral leaflets on the outer side of each partial umbel. A safe mode, however, of avoiding at all times unpleasant consequences from its being mistaken for parsley, is to cultivate and use only the curly-leaved varieties of the latter: the leaves of the fool's parsley being perfectly flat.

Aëtiaioi (Gr. from ἀετός, *a pediment*). In Architecture, the name given by the Greek architects to the slabs forming the face of the tympanum of a pediment. This word occurs in the Athenian inscription now in the British Museum, brought to England by Dr. Chandler, and relating to the survey of some temple at Athens.

Ætiology (Gr. αἰτία, *a cause*, and λόγος, *discourse*). The doctrine of the causes of disease.

Ætites (Gr. ἀετός, *an eagle*). A term given by Pliny to hollow stones composed of several crusts one within another. By Kirwan the name is used to denote those kinds of iron-ore (clay-ironstone), which are composed of a reniform or globular crust of oxide investing an ochreous kernel. The name originated in the ancient belief that such stones formed part of an eagle's nest.

Affectation (Lat. affectatio). In the Fine Arts, an artificial show arising from the want of simplicity either in colouring, drawing, or action. Also, the over-charging any part of a composition with an artificial or deceitful appearance.

Affected, or **Adfected** (Lat. affectus). A term used in Algebra. When applied to an equation, it signifies that two or more powers of the unknown quantity enter into the equation: thus, $x^2 + ax + b = o$ is termed an *adfected* quadratic, to distinguish it from $x^2 + c = o$; which is a *pure* quadratic. When the term is applied to a quantity, it implies that the latter has a coefficient, or a proper sign: thus, in the quantity $+ 2x$, x is said to be affected with the coefficient 2, and with the sign +. Dr. Hutton thinks the term affected was introduced into Algebra by Vieta.

Afferent (Lat. afferens). The term, in Anatomy, applied to those lymphatic vessels which enter the lymphatic glands, subdivide, and form tortuous plexuses therein, whence other vessels proceed, converge, and unite into two or more efferent vessels which are larger than the afferent ones, and proceed towards the main trunk called 'thoracic duct.' The term *afferent* has also been applied to those nerves which convey impressions to the central axis, and which Hartley called 'sensory' nerves, in contradistinction to the efferent or 'motory' nerves.

Affetto, or **Affettuoso** (Ital.). In Music, a term prefixed to a movement, showing that it is to be performed in a smooth, tender and affecting manner, and, therefore, rather inclining to slowness than the reverse.

Affidavit (Low Lat. affido, *I confirm by oath*). In Law, is an oath in writing, sworn before some person who has authority to administer it. Affidavits are ruled by the rules of practice at Common Law.—Hil. T. 1853, rr. 138—148.

Affiliation (Lat. affilio, *I adopt*). In Law, the assignment of a child to a parent by legal authority; as where the father of a bastard child is designated on the testimony of the woman, and the expenses of maintaining it cast upon him. By the Poor Law Amendment Act, s. 72, this can now only be done, after sufficient notice to the party intended to be charged, by an order of the court of quarter sessions, on the testimony of the woman, corroborated as to some material fact by other evidence. [BASTARD.]

Affiliated Societies, in Politics, are local societies, depending on a central society with which they correspond, and from which they receive directions. Such were the provincial Jacobin clubs, founded on the model of the Jacobin club of Paris. Such, also, were the Corresponding Societies in England, for the suppression of which the statute 39 G. 3, c. 79, was chiefly passed.

Affinity (Lat. affinitas). A relation of animals to one another, in the similarity of a greater proportion of their organisation: thus, a porpoise is said to have an affinity to man, because of its resemblance to him in the respiratory, circulating, and generative systems, in the brain, eye, ear, &c.; while it is said to have an analogy to a fish, because the resemblance is confined to external form. In short, affinity is that degree of relationship by which, in forming a concatenated series of animals, we pass from one to another by the closest gradations.

AFFINITY. In Botany, when the relation which plants or groups of plants bear to one another is very close, and depends on some striking resemblance between important organs. The term is used in contradistinction to analogy, when the resemblance lies between organs of less importance. Thus the foliage of *Lathyrus Nissolia* resembles that of a grass; but there is no affinity between the dicotyledonous *Lathyrus* and the monocotyledonous grass.

AFFINITY. In Law, as distinguished from consanguinity, signifies the relation which a man and woman by marriage contract towards the kindred of each other. From early times in the Christian church, this kind of relationship was esteemed to have the same effect as relationship by consanguinity in causing impediments to marriage; a rule chiefly founded, or alleged to be so, on the received interpretation of the eighteenth chapter of Leviticus. Until 1835, marriages of this class were voidable only in England. In that year an act passed (5 & 6 Will. 4, c. 54) which prohibited

them absolutely for the future, at the same time rendering valid those which existed.

Affinity, Chemical. The attractive force by which dissimilar substances combine with each other to produce chemical compounds. All natural and artificial substances are either simple or compound. The metals, for instance, are simple substances—no one of them having been as yet decomposed: water is a compound; it may be resolved into oxygen and hydrogen gases, which are therefore called its component parts. To enable substances to exert their mutual affinities, or to act chemically upon each other, the opposing powers of matter must be overcome, and they must be placed under circumstances favourable to the exertion of their mutual chemical attractions. Two solid bodies seldom combine, in consequence of their imperfect contact, and the immobility of their particles; hence the old axiom, *corpora non agunt, nisi fluida.* But to this there are exceptions: ice and salt, for instance, run down into liquid brine; dry oxalic acid and dry lime unite; and when sulphur and chlorate of potash are rubbed together, they act violently on each other. Even when one or both substances are fluid, heat is often requisite to diminish cohesion, and promote affinity: thus, mercury and iron combine with melted sulphur; and oxygen and hydrogen, and oxygen and carbon, require heat to effect their union. In some cases the action of the solar rays excites and increases affinity, as in the combination of hydrogen and chlorine.

The investigation of the relative proportions in which bodies combine, forms the basis of the atomic theory, or doctrine of chemical equivalents.

Many substances seem to unite in all proportions; but these are not strict cases of chemical combination: thus, water and sulphuric acid, and alcohol and ether, mix together in any quantities. Others unite indefinitely, up to a certain point: water, for instance, dissolves salt, in variable quantity, till the solution is saturated: we thus find that a given quantity of water is only able to retain a certain weight of salt in permanent solution. In these cases of indefinite combination, the affinities of the combining substances are usually feeble; but where their affinities or attractive powers are energetic, there is a remarkable tendency to combine in certain proportions only. Thus, sulphuric acid and lime unite in the proportions of 40 of the acid to 28 of the lime, and in no other or intermediate quantity: in such cases the acid and the base are said to neutralise each other; and such compounds are often called neutral salts, that is, salts in which the leading characters of the component parts are no longer perceptible, which are neither acid nor alkaline. When bodies combine in more than one proportion, which is often the case, the second, third, &c., proportions are simple multiples of the first: thus, 16 parts of sulphur combine respectively with 8, 16, and 24 of oxygen; in these compounds the relative proportions of oxygen being as 1, 2, and 3. Again, 14 parts of nitrogen combine with 8, 16, 24, 32, and 40 of oxygen, forming five distinct compounds, in which the relative proportions of the oxygen are as 1, 2, 3, 4, and 5.

Where the combining substances are either naturally gaseous, or where they may be hypothetically so considered, it is obvious that, as their weights bear these simple relations to each other, their bulks or volumes will do so likewise: thus, in the case of the compounds just noticed, 1 volume of nitrogen will combine respectively with $\frac{1}{2}$, 1, $1\frac{1}{2}$, 2, and $2\frac{1}{2}$ volumes of oxygen; or, what amounts to the same thing, 2 volumes of nitrogen will combine with 1, 2, 3, 4, and 5 volumes of oxygen.

As bodies thus combine with each other in definite proportions, it is obvious, that if we select any one substance as unity, or $=1$, all other substances may be represented by numbers equal to the weights in which they respectively combine with each other, and with the unit. Upon this principle of numeric representation, hydrogen, which is the lightest known substance, is assumed as unity; the compound of hydrogen with oxygen is water, in which 1 part by weight of hydrogen is combined with 8 of oxygen, to form 9 of water; hence, in a table of atomic weights, definite proportionals, or chemical equivalents, (for all these terms have been applied to such numbers), we have—

Hydrogen	represented by		1
Oxygen	"	"	8
Water	"	"	9

And in the above series of nitric compounds we have, in the first of them, 14 of nitrogen combined with 8 of oxygen; and, accordingly, calling 14 the equivalent of nitrogen, and 8 the equivalent of oxygen, we have the following equivalents of their compounds; and it may be presumed that these numbers represent the weights of the combining atoms of those bodies:—

Atoms of nitrogen		Atoms of oxygen	Equivalents, or combining weights, of nitrogen		Equivalents, or combining weights, of oxygen		Equivalents of the compounds
1	+	1	14	+	8	=	22 nitrous oxide
1	+	2	14	+	16	=	30 nitric oxide
1	+	3	14	+	24	=	38 hyponitrous acid
1	+	4	14	+	32	=	46 nitrous acid
1	+	5	14	+	40	=	54 nitric acid

This table also shows the nomenclature commonly applied to the compounds; the termination *ous* indicating the minimum of oxygen, the termination *ic* the maximum; the term oxide implying generally all those combinations of oxygen which are not sour, such being called acids. More frequently the relative proportions of oxygen in the oxides are designated by the first syllable of the Greek ordinal numerals: thus we have protoxides, deutoxides, tritoxides, &c.; and when the base is saturated

with oxygen, the compound is termed a peroxide. When the same substance forms three or four acids, the term hypo is conveniently introduced with the termination *ous* or *ic*, as shown in the following table of acids of sulphur :—

Atoms of sulphur		Atoms of oxygen	Equivalents of sulphur		Equivalents of oxygen		Equivalents of the acids
1	+	1	16	+	8	=	24 hyposulphurous
1	+	2	16	+	16	=	32 sulphurous
1	+	3	16	+	24	=	40 sulphuric

There is also an acid of sulphur intermediate between sulphurous and sulphuric, composed of 1 atom of hyposulphurous acid and 1 of sulphurous acid ; $(24+32=56)$ or of 2 atoms of sulphur and 3 of oxygen: this is appropriately called the hyposulphuric acid. The terms *sesqui* and *bi* are sometimes used to designate intermediate and double compounds of acids, or other bodies with bases: thus, we have three compounds of carbonic acid with ammonia, in which 1 proportional or atom of ammonia is respectively combined with 1, $1\frac{1}{2}$, and 2 of carbonic acid, and these we call the carbonate, sesquicarbonate, and bicarbonate of ammonia. For a table of the equivalent numbers of the simple substances, see EQUIVALENTS.

Change of form and change of properties are the common consequences of chemical affinity. We observe, 1. Solids forming liquids (ice and salt). 2. Solids forming gases (explosion of gunpowder). 3. A solid and a liquid producing a solid (lime and water). 4. A solid and a liquid producing a liquid (all common cases of solution; as of salt and sugar in water). 5. Liquids producing solids (solution of carbonate of potassa mixed with muriate of lime). 6. Liquids producing gases (alcohol and nitric acid). 7. Gases producing solids (ammonia and muriatic acid). 8. Gases producing liquids (chlorine and olefiant gas).

The density of bodies is also materially affected by chemical combination ; the density of a compound is very rarely the mean of its components, but generally increased: thus, almost all gaseous compounds occupy less bulk than their elementary gases in a separate state; there are, however, cases in which 1 volume of one gas, combined with 1 volume of another, produce exactly 2 volumes of a compound gas, the density of which is, of course, the mean of that of its components; and again, in the combinations of some of the metals with each other, and with sulphur, the density of the compound is below the mean of its elements. When certain liquids are mixed, great and immediate increase of density ensues, and much heat is evolved (sulphuric acid and water). Change of form and of density are often attended by remarkable changes in other qualities: thus, tasteless bodies produce active compounds (oil of vitriol is composed of oxygen, sulphur, and water), and active substances produce inert compounds (sulphuric acid and caustic potash produce the inert salt, sulphate of potash); so that it is utterly impossible, by any *à priori* reasoning, to determine what will be the consequence of chemical combination: useless elements produce useful compounds, and useless compounds yield useful elements.

Another important and curious consequence of chemical action is change of colour: the vegetable blues are generally reddened by acids, and rendered green by alkalis; the alkalis render many of the reds purple; and of the yellows, brown: chlorine destroys most colours; so does the joint action of light, air, and moisture (bleaching, &c.).

Affirmation (Lat. affirmatio). In English Law, a solemn declaration made, in cases authorised by law, by persons statutably relieved from the necessity of taking oaths. This relief, early granted to Quakers and members of some other persuasions, was extended by the Common Law Procedure Act, 1854, to all persons having conscientious objections. A false declaration or affirmation is punishable as perjury.

Affirmative. In Logic, denotes the quality of a proposition which asserts the agreement of the predicate with the subject.

Affirmative Quantity. [POSITIVE QUANTITY.]

Affirmative sign, or Positive sign. The sign of addition, marked +, meaning plus, or more. Dr. Hutton observes, that the early writers on algebra used the word plus in Latin, or piu in Italian, for addition, and afterwards the initial *p* only as a contraction, as they used minus or meno, or the initial *m* only, for subtraction; and thus their operations were denoted in Italy by Lucas de Burgo, Tartalea, and Cardan, while the signs + and − were employed much about the same time in Germany by Stifelius, Scheubelius, and others, to denote the same operations.

Affix. In Grammar, a syllable attached to the end of a class of words, determining their meaning. Thus, a class of adverbs in English is determined by the affix *ly*; strongly, weakly, &c. A prefix is a syllable so attached at the beginning.

Affrontée (Fr. affronter, *to face*). In Heraldry, a term applied to animals placed to face each other.

Afrancesados (Span.). In Modern History, a denomination given in Spain to the party which attached itself to the cause of the French, or of the intrusive king Joseph, during the war of independence, 1808—1814.

Africa. The continent of Africa is about 5300 miles in length from north to south, and nearly as much in extreme breadth from east to west; but its shape is triangular, and its area does not exceed twelve millions of square miles. The total length of its coast line is less than 15,000 miles, showing an amount of deviation from a straight line, and a smallness of indentation, extremely remarkable. It has few navigable rivers, and the interior is therefore reached with diffic lty. The mouths of its rivers are all swampy, and extremely subject to malaria. Its lakes are numerous and perhaps occasionally

connected, but generally mere large ponds with no defined margin. Its deserts are large and for the most part are without water courses. In many important respects, the interior of Africa is totally unlike the interior of Europe or Asia, or either of the two Americas. It bears a kind of analogy to the interior of Australia, but there are points of essential difference.

Till within the present century, the interior of Africa was very imperfectly known to the inhabitants of Europe, although its northern part has been traversed from time immemorial by Arabs.

As now known, the northernmost part of this continent, consisting of the Atlas mountains, more properly belongs to the European land. The rest between the Atlas chain and the equator consists of the GREAT SAHARA [which see], terminated eastwards by the Nile and Abyssinia, which is a mountain country. The southern portions are for the most part vast tracts of nearly level land, enclosed by coast ranges, and watered by rivers which carry little water into the sea. The coast range is a wide table land, on which are lakes at high levels. An extensive desert occupies the whole of the southern district within the table land for a considerable distance, but it is only barren during the dry season.

Africa abounds with large quadrupeds, and is chiefly peopled by various tribes of black or coloured men. These for the most part are low in the scale of intellect, especially when inhabiting the low swamps and unhealthy lands of the coast. The vegetation is peculiarly interesting.

Africa contains much mineral wealth. Gold has been found abundantly in the coast range on the west side, and exists also on the east. Copper also abounds, and has been worked in the mountains of the Lesser Atlas, in the coast range on the west coast near the Cape of Good Hope, and elsewhere on the south coast; and also on the east coast in various places iron would seem to abound.

The greater part of the African coast being within the tropics, and the rivers and streams for the most part choked before entering the sea, the climate of the coast is generally very unhealthy. Fevers and miasma also abound in many parts of the interior that have been visited. The country near the Cape of Good Hope is generally healthy.

Lake Systems.—The lake systems of Africa are strictly connected with the physical structure of the country, and are of great importance to a right understanding of its physical geography. They are of two classes:—those of the one occupying depressions in the steps of table land, which surround the whole of the continent south of the equator, and those of the other forming mere pools or expansions of the rivers in the central districts.

Of the former the lake Tanganyika is an example occupying a depression of a thousand feet in a plateau of three thousand feet and receiving the drainage of a large area. It is about 500 miles from the coast. A little to the north, but nearer to the coast, is the great lake Nyanza, at a higher level, and running northwards towards the equator, connecting with the Nile. South of this, at some distance, but probably part of the same chain, is the lake Shire, partially explored by Dr. Livingstone. All these, and probably many other lakes on the east side of Africa, occupy similar depressions in the great plateau, and are more or less parts of one system.

The lakes on the western side and in the north of Africa near the equator are in the lower lands, and consist of expansions of rivers or of pools enlarged by annual or occasional rains. Such are lake Tchad, lake Ngami, and the Bahr-el-Gazul, an occasional expansion of the Nile recently explored by Consul Petherick. There are probably others in the course of the Zambesi.

Mountain Chains.—Contrary to the opinion long entertained, there seems no reason to suppose that the mountain systems of Africa at all resemble those of Asia, Europe and America. Except the Great Atlas, a chain which may be regarded as part of the great mountain axis of the Old World, branching off on the south of the Mediterranean basin, there is no transverse chain in Africa, unless the reports and statements made by M. du Chaillu, on the west coast, possess more value than the evidence warrants us in supposing. On the east side indeed, in and near Abyssinia, is a very lofty mountain district extending from near the equator towards the north, but this seems rather the termination westwards of the great Asiatic high lands than part of a separate axis. All the rest of the African high lands appear to be rather plateaux than chains: African land therefore consists of a triangular plain of low elevation surrounded and enclosed by high table land rising at intervals into mountains.

Rivers.—In accordance with the peculiar condition of the mountain chain and table land of Africa, and in connection with its lakes, the river systems are few in number, and, with the exception of the Nile, and perhaps the Orange river, have little resemblance, in the mode of their passing through and collecting the drainage of the land, to the streams of most other countries. The Nile probably drains only the north-eastern extremity of Africa; for although some of its affluents take their rise south of the equator, these probably connect themselves with the great chain of lakes of which the Nyanza is the largest. Some of the actual sources of the Nile near the equator have lately been traced by Capt. Speke, but it has not yet been decided whether or not there is an important branch coming in from the west. Of the other rivers of Africa, the Zambesi and the Niger or Quorra are the largest and most important. The Orange and the Ogobai are also of considerable interest. The latter is supposed by M. du Chaillu to take its rise in the far interior of the continent.

The Nile is one of the principal rivers of the world, both in the direct length of its course, which is more than two thousand miles, and in the vast area it drains, which is estimated at three quarters of a million of square miles, and may be much larger. Belonging to the Mediterranean system of drainage, it penetrates Africa south of the equator; and no other stream of any kind carrying off water from the eastern half of Africa in north latitude can be even named. The Quorra or Niger is perhaps little inferior either in drainage area or in length of course to the Nile, though much less known. It drains the western part of Africa north of the equator, but south of the desert.

The Zambesi, whose course has been clearly indicated by Dr. Livingstone, is, however, yet more remarkable. Rising near the table land of the west coast near Loanda, about 12° south of the equator, and fed by numerous streams draining (if the term can be properly applied in this case) a vast irregular oval area, part of the central plateau of Africa, this remarkable stream continues its course sometimes smooth, wide and deep, sometimes broken by waterfalls of great beauty, sometimes breaking up into a multitude of streamlets; and at length the whole body of water, after coursing for two or three thousand miles in the interior, is almost lost, or at least has only an obstructed and dangerous channel to the sea on the south-east coast, oozing through a wide indentation of the table land without dignity or grandeur. Close to the coast it receives a large tributary, connected with the great chain of lakes on the plateau parallel to the east coast.

The rivers of Africa thus afford matter for study not less interesting and exceptional than the lakes and mountains. Everything in this continent is indeed unlike the corresponding phenomena in Europe, Asia, and America, and the interior more resembles a depressed basin than a range of land brought up by a mountain axis. As we have already remarked, the condition of Australia presents some analogy, but the differences are marked and characteristic.

Africa is almost without evidences of volcanic action, except on the north-east coast in the lofty mountains near Abyssinia.

Aft. A relative term used on board ship to signify position behind or near the stern.

After-damp. This is chiefly carbonic acid gas. It is the invariable product of combustion of coal, fat, gas, &c., but under ordinary circumstances is so rapidly diffused into, and diluted by, the air, that its suffocating action on the system does not obtain. In coal mines, however, it is produced during an explosion at the expense of the oxygen of the air of the mine, and then generally contains carbonic oxide, thus forming with the residual nitrogen an atmosphere in which animal life cannot possibly be sustained.

Aftermath. In Agriculture, grass which is mown after the first crop of hay has been taken away, instead of being eaten off by stock.

Aga. A title of dignity among the Turks and Persians, given to various officers, as the aga of the janissaries, &c. It is also a common epithet of respect in addressing a distinguished person.

Agalmatolite (Gr. ἄγαλμα, *an image*, and λίθος, *stone*). An altered clay or clay-slate, which is carved into images, &c., by the Chinese. It occurs massive, of various shades of greenish-grey, passing into yellowish-grey and yellowish-brown, &c.; translucent; feels rather greasy, is sectile, and yields to the nail. It is found in Cornwall at the Restormel Iron Mines, of a pale flesh colour; at Glyder Bach, in Caernarvonshire; Lugganure Mines, Co. Wicklow; also in China, Saxony, Transylvania, Norway, &c.

Agama. The name of a lizard, employed by Cuvier to designate the first section of the Iguanian sauria, or *Agamidæ*; which section is characterised by the absence of palatal teeth. The Agamoid lizards include several genera, which are numerous in species, and they are distributed over the warmer parts of America, Africa, Asia, and Australia.

Agamous (Gr. ἄγαμος). A term substituted by some writers for cryptogamic, because such plants were supposed to have no organs analogous to sexes: it is, however, usually limited to such groups as Confervæ, Lichens, and Fungi.

Agapæ (Gr. ἀγάπη, *love*). Love feasts, in use among the primitive Christians. After the celebration of the communion, the oblations which had been made in the temple, consisting of meat and bread which the rich had brought from their houses, were consumed at a common feast. There is some dispute whether in the apostolic times this feast did not take place before the communion, in more exact accordance with the circumstances attending the institution of the sacrament. The agapæ or feasts in churches were prohibited by the Council of Laodicea, A.D. 361, and the third of Carthage, A.D. 397.

Agapetæ (Gr. ἀγαπητός, *beloved*). Among the early Christians, women under vows of virginity who undertook to attend on and serve the clergy. The practice was condemned by St. Cyprian as well as by the acts of several councils.

Agaphite. [Turquoise.]

Agaric (Gr. ἀγαρικόν). A genus of Fungi comprehending many hundred species, among which are, *A. campestris*, the common mushroom, and some others, which are delicate articles of food; *A. muscarius* and others that are dangerous poisons; many of the disgusting deliquescent fungi called toad-stools; and numerous beautiful little ephemeral species, which appear to be harmless. *A. olearius* is remarkable for being phosphorescent. These plants uniformly grow in decaying animal or vegetable matter, among which their stem, or spawn, as it is commonly called, ramifies. After the spawn has arrived at the proper age, it ceases to branch, collects into parcels, and generates from those parcels the fructification, which forces its way into the light under the

form of the agaric. The cap is the part where the spores or seeds for reproducing the species are generated; they are formed within the plates or gills that lie on the under side of the cap, and are little variously coloured round bodies which, when they are collected in great quantities upon a sheet of white paper, have the appearance of exceedingly fine dust. 'Fairy rings' are caused by the underground stems of agarics, which branch from a common centre, and only protrude their fructification at the circumference.

Agaric Mineral. A soft and friable kind of nearly pure native carbonate of lime, found in the clefts of calcareous rocks, in limestone caverns, and at the bottom of certain lakes, the waters of which are charged with lime.

Agastrica, Agastria, Agastrica (Gr. ἀ, priv., γαστήρ, *a stomach; stomachless*). A term which has been applied to certain animalcules, on the erroneous supposition that they were devoid of internal digestive cavities. [POLYGASTRICA.] The term is still applied to a family of Medusæ.

Agate (Gr. ἀχάτης). A siliceous mineral of which the base generally appears to be chalcedony; but carnelian, jasper, amethyst, and other allied minerals, often enter into its composition. Owing to its hardness, which makes it take a fine polish, the variety of its colours, and the beautiful manner in which these are mixed and arranged, the Agate is much used for making ornaments. Most of the Agates of commerce are brought in a polished state from Oberstein, in Saxony, but they are also found in Scotland (SCOTCH PEBBLE), Siberia, Arabia (MOCHA STONE), India, Surinam, and many other countries, in the form of rounded nodules and hollow geodes embedded in trap rocks and serpentine. The various kinds of Agate, *Fortification Agate, Ribbon Agate, Moss Agate, Brecciated Agate*, &c. are described under their respective names. The name is said to be derived from that of the Achates, a river in Sicily.

Agathodæmon (Gr. ἀγαθοδαίμων). The good Genius or spirit, originally, perhaps, only an epithet of Zeus. (Pausanias, viii. 36, 3.) [DEMON.]

Agathotes (Gr. ἀγαθότης, *goodness*). A genus of the family of Gentians, the dried stems of a species of which, *A. Chirayta*, the chiretta, a native of Northern India, furnish a very pure bitter, very similar to gentian, and used medicinally.

Agave (Gr. ἀγαυός, *admirable*). A genus of plants found in the temperate parts of America, resembling aloes in their mode of growth and general appearance, but differing in having an inferior ovary, and in their sensible properties. The best known species is *Agave americana*, called the American aloe, which has been naturalised on the coasts of the Mediterranean, where it assists, with *Opuntia vulgaris*, the palmetto, and date palms, to give a tropical air to European scenery. It is many years preparing the materials for its gigantic pyramid of flowers, and is so exhausted by the effort that it quickly afterwards perishes. A sweet sap flows from its inward stem, and upon fermentation becomes an intoxicating beverage, yielding by distillation a powerful ardent spirit. Hemp of considerable strength is manufactured from its leaves. The genus *Agave* is the type of one of the subdivisions of amaryllidaceous plants.

Age (Fr. *âge*). Means generally a definite period or length of time. For the origin and history of this word, see Max Müller, *Lectures on the Science of Language*, First Series, p. 279, (1861).

AGE. As applied to man, age may either mean the whole of his life, or a portion of it. It is usual to divide the whole period of human life into four parts or ages. The first, or infancy, extending to the fourteenth year; the next, or youth, from the fourteenth to about the twenty-fifth; manhood, from the twenty-fifth to the fiftieth or sixtieth; and the last, or old age, filling up the remainder. Ovid ingeniously compares these four ages to the four different seasons of the year. — *Metamorph.* xv. 200. These divisions are, however, in a great degree arbitrary; and very frequently they have been extended to six, the first being divided into infancy and childhood, and the last into old age and extreme old age. Sometimes, also, the life of man is supposed to be divided into seven ages, the leading characteristics of which have been most admirably depicted by Shakespeare, *As you like it*, Act ii. scene 7.

For a scientific discussion of this subject, *see* MORTALITY.

AGE. In Chronology and History, age is sometimes used as synonymous with a century, and sometimes also with a generation. Writers differ in respect to the period included under what is called the *middle ages*; but they are commonly understood to begin with the reign of Constantine, and to extend to the fifteenth or the early part of the sixteenth century. The æra of the invention of printing may perhaps be most fitly assigned as their termination. The characteristics which distinguish the middle ages from more modern times are examined by Dr. Arnold, *Introductory Letters on Modern History*, p. 93, &c.

AGE. In Law, is the period at which individuals are qualified to undertake certain duties and offices. By the common law of England, a man at fourteen is at the age of discretion, and may then appoint guardians, and marry with their consent: at twenty-one he is of full age, and may, consequently, exercise any civil privilege to which he may otherwise be entitled, that is, he may elect or be elected to parliament, be appointed a judge, alienate lands, make valid contracts (not voidable, as those of infants are in general), &c. But no person can be admitted in England to deacon's orders till he be twenty-three years of age, nor to priest's till he be twenty-four. At twelve years a woman may marry, provided she have the consent of her parents or guardians; and at twenty-one she is her own

mistress, and may dispose of herself and her estates.

Infants under seven years are held by the law of England to be incapable of committing felony. If persons above that age, and under fourteen, commit felony, they are *prima facie* entitled to an acquittal; but if it appear to the court and the jury that the accused was *doli capax*, or clearly understood the nature of the crime he was committing, they may proceed on the principle that *malitia supplet ætatem*, and subject the offender, as, in point of fact, has been repeatedly done, to the extremest penalty of the law. Persons above fourteen are treated in this respect as if they had arrived at full age. (*Blackstone*, book iv. cap. 2.)

At Rome, the *consular age*, or the age at which a person became capable of holding the consular dignity, was fixed at forty-three, though in extraordinary cases this rule might be set aside. In France, a man is not allowed to exercise the elective franchise till he be twenty-five years of age; in some of the American states judges are obliged to retire when they have attained to a certain age, which is sometimes as early as sixty. The same age (sixty) is fixed by the English superannuation law of 1857 as that at which public servants may be permitted to retire on pension. According to Aristotle, thirty-five is the age at which the human body attains its perfection; forty-nine that for the mind—a notion which seems connected with the mystical properties of the number seven, the multiples of which form most of the received epochs in the age of man.

Age. In Literature, age is a period usually bearing the name of some powerful sovereign, or other prominent person, who flourished during that period. Of these ages, the most memorable are the age of Pericles, the Augustan age, the age of Leo X., &c.

Age. In Mythology, age means one of several periods through which the poets supposed the world to have passed. In Hesiod the Golden, Silver, and Brazen Ages are followed by the Heroic, after which comes the Age of Iron, which still continues. (Grote, *History of Greece*, vol. i. ch. 2.)

Agenda (Lat. *things to be done*). Small books are now published under this title, in which may be set down under their proper heads the things to be daily attended to.

Agenda. In Divinity, articles of moral practice, in opposition to *credenda*, articles of faith. Also, the ritual of a church, and the books containing it.

Agent (Lat. agens). In Law, is a person authorised to do some act or acts in the name of another, who is called his *principal*. An agent may, in general, be appointed by bare words, or his appointment will be inferred from circumstances; but for some purposes specified by the Statute of Frauds, his appointment must be in writing. The agent of a corporation must, in general, be appointed by deed. If an agent has engaged to perform certain duties for a consideration, the performance may be enforced in law. But against an unremunerated agent, the principal can only recover damages for misconduct in the performance, and cannot compel him to proceed. With respect to the dealings of third parties with an agent, some general rules of law are, that the extent of an agent's authority is, as between his principal and third parties, to be measured by the extent of his usual employment; that the representation of an agent about the subject-matter of a contract which he is negotiating for his principal will, if made during the course of the negotiation, bind the latter; that payment to an agent, in the course of his employment, is payment to the principal; that the principal is, under many circumstances, responsible in civil actions for the negligence or fraud of his agent, but not criminally liable for his acts, unless done under an express command.

Agent. In Diplomacy, a general name, comprising several ranks:—as, 1. Ambassadors. 2. Envoys extraordinary and Ministers plenipotentiary. 3. Ministers resident. 4. Chargés d'affaires. 5. Secretaries of legation, &c. In common language, however, the highest officer employed by one power at the court of another is usually termed the agent of that power at the court in question. [Diplomacy.]

Ageratum (Gr. ἀγήρατον). The name of this genus of *Compositæ*, which is adopted by the moderns from Dioscorides, was, it is supposed, applied by him to plants such as we now designate 'everlastings.' The modern genus contains but few species, one or two of which are cultivated for ornament, but none have any useful properties. Some of the plants once included in *Ageratum* are now referred to *Eupatorium*, *Stevia*, *Cœlestina*, *Piqueria*, and others. *Piqueria trinervia*, formerly called *A. febrifugum*, a Mexican herbaceous plant with white flowers, is used in Mexico as a remedy in intermittent fevers.

Agglutinate Languages. In Grammar, a term applied to the Turanian family of languages, to express the character of their formation. In the Aryan and Semitic languages conjugation and declension are the result of *gluing on* pronouns to verbs and nouns; but in them these terminations have coalesced so as to form practically a single word, and have, therefore, in greater or less degree, lost their original and independent force. In the Turanian languages the declension and conjugation can still be taken to pieces, and the affixes are felt to be distinct from the roots to which they are appended, as in Mongol, Turkish, &c. (Max Müller, *Lectures on the Science of Language*, First Series, Lect. viii.)

Aggregate Animals. This term is applied to those animals which are collected together in a common enveloping organised substance containing numerous compartments, from each of which a distinct occupant sends forth a circle of organs to collect food, which, after assimilation, is carried by a common and continuous system of vessels for the support and enlarge-

ment of the common dwelling. Examples of animals so associated or aggregated occur in the class Polypi, where they form most of the orders; also in the class Acalephæ, forming the Polytoma; and in the Acephalous Mollusca, forming the genera Botryllus, Pyrosoma, and Polyclinum.

Aggregated (Lat. adgregatus, *associated with*). In Mineralogy and Geology, a mineral or rock is said to be aggregated, when the several component parts only adhere to each other to such a degree as to be separable by mechanical means. Thus, in the case of granite, which is an aggregated rock, the Quartz, Felspar, and Mica of which it is composed, may be separated mechanically.

Aggregated Glands. Those secreting organs in which a number of compound vesicles or *acini* are arranged in groups, forming lobules. [CONGLOMERATE.] Such are the so-called mucous glands of the mouth, trachea, and vagina; the tonsils, salivary, pancreatic, and mammary glands; the lachrymal and Brunnian glands; Cowper's glands; and the prostate gland.

Agilia (Lat. agilis, *swift*). A family of Rodents in the system of Illiger, including squirrels and dormice.

Agio (Ital. aggio). A mercantile term, denoting the percentage difference existing between the values of the current and standard moneys of any place. Also, the rate of premium which is given, when a person having a claim which can only be legally demanded in one metal, chooses to be paid in another. Thus, in countries where silver is the only legal standard, a large payment in silver is so inconvenient, that the receiver will often pay a small premium for the convenience of receiving gold: this premium constitutes the agio on gold.

Agiotage. A term employed to designate the sort of manœuvres by which speculators in the public funds contrive, by disseminating false rumours, or otherwise, to lower or enhance their price. It is sometimes also, though less commonly, applied to the machinations of those who endeavour, by similar artifices, to raise or depress the prices of commodities.

Agiosymandrum (Gr. ἅγιος, *holy*, and σημαίνω, *I show by a sign*). A wooden instrument used in Christian churches in countries under the dominion of the Turks, who forbade the use of bells.

Agistment. In Law, from the old French word, *agister*, which signifies a licence granted for cattle, viz. to be harboured, or, in legal phrase, levant and couchant, on the land. A contract by which A.'s cattle are taken into B.'s ground, to remain there at a stipulated sum, paid periodically. Agistment is also used for the profits of such feeding. The 'Tithe of Agistment,' or of cattle and other produce of grass lands, demanded by the Irish clergy, was resisted, in 1720, by the landlords, and in effect abolished by a resolution of the Irish house of commons (1735). By the act of union, this resolution was passed into law; and thus the tithes of Ireland have, in effect, been thrown on the owners and cultivators of arable land. (*Ed. Rev.*, vol. xxxiv.; Wakefield's *Ireland*, vol. ii.)

Agminate Glands (Lat. agmen). The glands of Peyer, in the small intestines, where they are aggregated in groups, are so called: these groups are of various sizes, and usually of an oval form.

Agnate (Lat. agnatus). In Roman Law, *agnates* are those who descend through males from a common ancestor; in opposition to *cognates*, i.e. all the descendants of a common ancestor, whether through males or females. Thus, in France, by Salic law, the hereditary crown passes by right of *agnation*, females being excluded.

Agnesite. An earthy steatitic mineral found at Huel Coates, near St. Agnes, in Cornwall. It is probably an impure kind of bismuth-ochre.

Agnoetæ (Gr. ἀγνοέω, *I do not know*). In Ecclesiastical History, a sect of the sixth century, who maintained that Christ, in His human nature, was ignorant of many things, and particularly of the day of judgment. An earlier sect, so called, questioned the omniscience of God.

Agnomen (Lat.). Besides the prænomen, nomen, and cognomen, the Romans sometimes had a fourth name (agnomen), which was derived from some illustrious action or remarkable event. Thus, two Scipios had the name Africanus given them, on account of their victories over the Carthaginians in Africa. The younger of these celebrated generals had a second agnomen, viz. Æmilianus, because he was the son of L. Paulus Æmilius, and adopted into the family of the Scipios.

Agnon. A name applied by Fabricius to a genus of dragon-flies, having the wings erect when at rest, the eyes distinct, and the outer divisions of the lip bifid.

Agnostus (Gr. ἄγνωστος, *unknown*). A name devised to express the obscure nature of a genus of Trilobites (fossil Crustaceans), to which it is attached; the genus is characterised by the semicircular or reniform shape of the body, which in all other Trilobites is ovate or elliptical.

Agnus Dei (Lat. *Lamb of God*). 1. A prayer of the Roman Catholic church, which begins with the words, 'Agnus Dei qui tollis peccata mundi.' 2. Images of wax, impressed with the figure of the Lamb, consecrated by the pope, and distributed to the faithful.

Agomphians (Gr. ἀγόμφιος, *without grinder-teeth*). A term applied by Ehrenberg to those Rotifers of which the jaws are deprived of teeth.

Agonalia (Lat.). A Roman festival celebrated several times a year, in honour of the guardian deities of the state.

Agora (Gr. from ἀγείρω, *I gather*). The market place of a Greek town, which was generally used also as the place where the assem-

blies of the people met. It answers to the Latin term forum. From agora is derived

Agoranomus (Gr. ἀγορανόμος). The title of an Athenian magistrate, forming one of a body of ten, or, as some say, fifteen, persons, whose duty it was to superintend the markets, and collect the customs imposed on certain articles.

Agrarian Laws (Lat. agrariæ leges, from ager, *a field*). Under this term are comprehended the enactments which were carried, or attempted to be carried, at Rome by the plebeians and their partisans, in opposition to the patricians, touching the distribution made of the public lands accruing to the state by conquest. These were leased out to the patricians by the state at a moderate or nominal rent, while the plebeians gained nothing by them. The object of the agrarian laws, which did not interfere with private freehold property, was to obtain for the plebeians a share in these lands, to restrict the quantity occupied by individuals, and to cause a real rent to be paid from them for the support of the army. The most celebrated movers of these laws were, Sp. Cassius, Licinius, and the two Gracchi. For a more impartial investigation of them than can be found in ancient writers, (for Cicero, from his aristocratic partisanship, has much misrepresented the objects of these reformers, and the character of the laws they sought to introduce,) see Niebuhr's *Roman History*, and Sir G. C. Lewis *On the Credibility of Early Roman History*. In consequence of the misrepresentations here referred to, the term 'Agrarian law' in Politics now generally serves to denote a law for the spoliation of individuals, by reducing landed property in private hands to a fixed amount.

Agreement (Fr. agrément). In the Fine Arts, a certain degree of resemblance between the parts, in style and character, so that they may seem to belong to each other.

Agreement. In Law, that which is consented to by two or more parties. Agreements are divided into executed and executory. By the Statute of Frauds, 29 Car. 2, c. 3, no action can be brought to charge a defendant on any agreement upon consideration of marriage, or on any contract or sale of lands, &c., or any interest therein, or any agreement not to be performed within one year, unless such agreement, or some memorandum or note of it, be in writing, signed by the party to be charged therewith, or some other person by him thereunto lawfully authorised.

The remedy which law affords for the breach of an agreement is only by way of damages. But equity will in general compel the specific performance of any contract or agreement for the non-performance or breach of which a court of law could have awarded damages. The principal exception to this rule is, where the agreement is of such a nature that its breach can be or was intended to be compensated by damages.

Agricultural Chemistry. That part of chemical science which relates especially to agriculture. It more particularly demands a knowledge of the composition of the atmosphere, the soil, and the plant, and their action upon each other in the presence of moisture; and enables the farmer to manure, in the broadest sense of the word, that is, renew impaired soil, and improve land that naturally is unfertile, to the greatest advantage. The successful and economical operations on farm produce depend also to a large extent on chemical principles, and can only be fully appreciated and best carried out by individuals possessing some knowledge of chemistry.

Agricultural Geology. To the agriculturist geology is chiefly valuable as teaching the probable resources of a district in soil, subsoil, and mineral manure. So far as relates to Draining and Water-supply, they will be found explained in those articles.

A geological map explains (by referring to the index of colours) the kind of rock that may be expected to underlie any particular district. It is quite possible that the rock near the surface may differ widely from the soil, for the fine particles of the latter may have been conveyed by water from a distance. The map therefore teaches what the soil conceals, and may lead to important practical results. Thus, if a geological map should indicate the probability of limestone or sand beneath a stiff clay, it might be worth while to bore to prove the existence of the limestone or sand, and afterwards to sink a quarry to obtain material for liming the clay or converting the clay into loam. Many such illustrations of the use of geology to the agriculturist will readily suggest themselves.

Generally speaking, the subsoil is derived directly from the underlying rock, and the soil is derived from the subsoil; a certain amount of disintegration and decomposition, always going on under the ordinary influences of weather, tends to perpetuate this condition, and thus in most cases the soil indicates the rock. In any estimate of the value of property, the nature of the underlying rock comes into consideration, for both the depth and texture of the soil are almost sure to depend on the rock beneath, and the fertility is evidently dependant on these. The mechanical condition of a soil may often be greatly altered by mixture with a favourable rock, out of sight, but whose existence in the neighbourhood is learned by geological investigation.

In the valuation of estates the importance of geology is especially felt, inasmuch as the resources of the land cannot be fairly estimated without including this element.

To the farmer it is often desirable that he should know the probable result of deep draining and deep ploughing. These depend greatly on the nature of the rock, the dip and compactness of the strata, and the form of the surface in reference to the stratification. Thus, in all respects some knowledge of geology is necessary for agricultural purposes.

Even the fossils that are found in, and are

characteristics of, rocks are occasionally valuable for practical work. Thus the COPROLITES recently discovered and worked in the east of England have greatly increased the value of the lands where they occur, and shells are sometimes very valuable. Certain rocks seem especially rich in phosphates, and others, owing to the presence of other mineral phosphates, are of extraordinary fertility. Such are the *Tchor nozem* or black earth of the Aralo-Caspian hills, and the *Regur* or cotton-soil of India.

Agriculture (Lat. agricultura, from ager, *a field*, and colo, *I till*). This art may be defined to be that of cultivating land in fields, or in large quantities, as opposed to horticulture, which is the art of cultivating land in gardens, or in small quantities: or, agriculture may be defined as the art of cultivating land with the plough, and horticulture that of cultivating it with the spade. The restricted meaning of the word agriculture, therefore, is simply the art of cultivating fields; but its more extensive and general meaning includes the whole business of the farmer, which comprehends, in addition to raising corn and other crops, the management of live stock. As a general term, the word agriculture is also frequently considered as including every description of territorial improvement; thus it is made to comprehend embanking, road-making, draining, planting, and sometimes even horticulture. In this sense the word agriculture is used by the French writers on the subject.

We shall here consider the term agriculture in its general acceptation in Britain, and in other countries where the English language prevails, as only including the culture of field crops, and the rearing and managing of domestic animals, on a large scale; and we shall give a very concise outline of its origin, history, theory, and practice.

The origin of Agriculture must doubtless have been coeval with that of fixed property. In the primæval state of society, the sole riches of the husbandman consisted of flocks and herds, which were kept in a state of movement from one point to another, in search of pasturage and water; but as population increased, mankind adopted a fixed abode; this could only be done by bestowing on the site a certain degree of labour and care, which became, as it were, the price paid for constituting it private property. At this point in the progress of civilisation agriculture may be said to have commenced. Previously, the natural products of the soil were merely consumed where they were found; but now man sought to increase them by culture.

History of Agriculture. The culture of the land will be found to have depended, in every country, principally on its climate and its civilisation; though partly, also, on its government and population. In the warmer climates, where nature produces fruits in the greatest abundance for the food both of men and animals, and where very little care is required to procure shelter or clothing, agriculture has made little progress; because it is comparatively unnecessary for the prosperity of the inhabitants. In climates of a directly opposite character, agriculture has made equally slight progress, from the natural obstacles opposed to it. In such countries, for example, as Greenland and Kamschatka, only one or two kinds of corn crops can be cultivated, and perennial grasses can scarcely exist, because the ground is covered with snow for eight months in the year: and in these countries agriculture is but little practised, as the chief resources of the inhabitants for food are found in the sea and the forest. In intermediate climates, such as those of the south of Britain, the middle of France, and the north of Italy, the soil admits of labour by man throughout the whole year; and there is scarcely any limit to the kind of crops that may be raised on it. In such climates, agriculture is calculated to attain the highest degree of perfection; and comparing the different parts of the zones with this description of climate in both hemispheres, we may perhaps assert that the best agriculture in the world is to be found in Britain, Belgium, and North Italy. The kind of agriculture practised in different countries is also of course adapted to the difference of climate. Thus, towards the north, the great art of the cultivator would consist in supplying heat; or, rather, in adopting such measures as would best guard plants and animals against cold, rains, and the vicissitudes of the weather. Towards the south, on the other hand, the art of the cultivator would be chiefly directed to moderating extreme heat, and supplying moisture. It thus appears that the agriculture of any country necessarily depends on its latitude; and that in high and low latitudes, where there are greater extremes of temperature and climate to contend with, agriculture must be of a more difficult and hazardous description than in intermediate or temperate climates, such as that of Syria, where the art is supposed to have originated, or in Europe, where it may be considered as having attained its highest degree of perfection.

In tracing the progress of this art in civilised countries, we have only to follow the chronology of general history. As the Greeks and Romans appear to have arrived at as great a degree of perfection in legislation as the moderns, so they appear to have attained nearly equal excellence in the practice of agriculture. Till within the present century very little difference existed between the most approved agriculture of climates analogous to that of Italy, and the agriculture of the Romans as described by Cato, Columella, and other ancient writers. The chief superiority of the moderns consists in their machinery, and in their knowledge of the science of the art; the last being of very recent date, and by no means general among practitioners. By science, improved breeds, both of plants and animals, have been originated; and by improved machinery, a more perfect tillage has been produced, and also a

more complete separation of the produce from the soil, from the refuse of the plants and other impurities.

The history of agriculture in Britain begins with that of the Roman conquest. Julius Cæsar found the inhabitants in a state of semi-barbarism; but Agricola left them in possession of all the arts of civilisation then known. Agriculture declined with the invasion of the Saxons; but was preserved through the dark ages after the establishment of Christianity, by the intelligence of the members of the religious establishments, who gradually became possessed of the greater part of the landed property of the country. Agriculture revived in the reign of Henry VIII., and in that of Elizabeth, during the long period of peace which then prevailed, and the consequent security of property. It afterwards declined during the civil wars, but again revived during the reigns of William and Mary, Queen Anne, and George I., in consequence of the introduction of the Flemish husbandry, which included the culture of turnips and clover. A still greater stimulus to the art was given during the reign of George III. by the introduction of ploughs drawn by two horses, instead of four or six; of the drill system, and its application to the culture of turnips and potatoes; and by the improvement made in the breeding and rearing of live stock. Early in the present century, the threshing machine was an important addition to agricultural machinery; the reaping machine, the frequent drain system, and the subsoil plough, are improvements now coming into use; and the next grand step will be the general application of steam, instead of horses or cattle, to tillage and other field operations.

The literature of Agriculture commences with the works of the Romans, of which Columella's work, *De Re rustica*, may be considered the most comprehensive. In the dawn of modern agriculture, the principal writers were, Crescentius in Italy, Herrera in Spain, Olivier de Serres in France, Hereshbachius in Germany, and Fitzherbert in England. At the beginning of the present century the most comprehensive author on agriculture in Italy was Filippo Re; in France, Tessier; in Germany, Thayer; and in England, Marshall. The best work from which a general idea may be obtained of the agriculture of France and corresponding climates is, *Maison Rustique du xix[e] siècle; ou, Encyclopédie d'Agriculture pratique*, complete in one thick volume, 8vo.; and the corresponding works in Britain are Loudon's *Encyclopædia of Agriculture*, Stephen's *Book of the Farm*, Morton's *Cyclopædia of Agriculture*, and Wilson's *British Farming*.

The theory of Agriculture is founded on a knowledge of the nature of plants and of animals, of soils and manures; and of the climate, the seasons, and the weather. Plants are organised beings, which take up their food, by roots from the soil, and by leaves from the air: animals are organised beings which select their food from vegetables growing on the surface of the soil, or from other animals, and this food is prepared, before being absorbed into the system, by means of a stomach. The climate of a country determines both the plants and the animals which can be produced in it, while the seasons and the weather mark the time when the plants and animals of the given climate are in particular states of vigour or torpidity, and when certain operations of culture can be performed on them or on the soil.

The nature of the elementary materials being understood, even though imperfectly, certain improvements can be effected in them by art, which are greatly conducive to the increase of agricultural produce. The kinds of plants and animals suitable to any given climate, soil, or season, are determined by the laws of nature; but from among these kinds it is in the power of man to make a selection; and with the plants and animals so selected to originate others, adapted to his purposes in a superior degree. Hence the importance of selecting certain breeds of animals rather than others; and of making choice, not merely of one kind of bread-corn rather than another, but of particular varieties of that corn. Thus, in the case of wheat, there are some kinds the grains of which, under no circumstances, weigh more than sixty pounds a bushel; while there are others which never weigh less than sixty pounds a bushel. The nourishment of plants has been found to depend chiefly on inorganic matters contained in the soil, either originally present in it, or supplied by the decay of vegetable and animal matters. This is a law of nature, which, followed up by man, has led to the use of manures; just as the fact, everywhere observed, that no plant can live without water, has led to irrigation; and as the observation that the excess of water is injurious, has led to surface and under draining. The influence of temperature and shelter over the growth of plants and the thriving of animals, is everywhere observable in wild nature; and though the temperature of a climate cannot be changed, yet that of most localities may be improved by shelter from cold winds, and by diminishing the evaporation from the surface, by means of surface and under draining, to draw off the superfluous water. The most important principles in the theory of agriculture are those which relate to the improvement of plants and animals, and of the soil.

The improvement of the soil may be comprised under two heads—the improvement of its earthy part, and the increase of the fertilising matters added to this earth. The improvement of the soil, considered as a mixture of different earths, consists in rendering it more or less retentive of water, by diminishing or increasing the size of the particles of which it is composed: for example, by the addition of clay in some cases, and sand in others; and by improving the earthy composition of the soil by the addition of such earths as may be in too small quantities, or wanting altogether. It has

been found, from experience, that those soils which are composed of several primitive earths are naturally more productive than such as consist of only one earth, all other circumstances being the same; and it has also been found that no soil will maintain its fertility for any length of time that does not contain a certain portion of calcareous earth in its composition. Hence one of the most common means of improving all soils not calcareous is, by the addition of lime; and of all other soils, by mixing them with such as are of an opposite description.

All soils whatever are rendered more productive by the addition of what are called *manures*. Manures may either be composed of animal or of vegetable matter, or of such mineral and inorganic substances as are found in the ash of plants. Organic manures may be applied either separately or mixed, and in a fresh state, or in a state of decay. It has been found from experience, and explained by chemical experiments, that they are ineffective until they undergo putrefactive fermentation; and this process is carried on either slowly in the land itself, or previous to application, with solid manure in heaps or dunghills, and with liquid manure in tanks or wells. In the application of manure to soils, the great object of the cultivator is to apply enough for the ensuing crop, and as little more as possible; because that which is applied and not immediately used is liable, to a certain extent, to have its particles carried off by evaporation into the atmosphere, or by rains into rivers or the sea. But, even if this were not the case, to apply manure to a soil where it would not be immediately turned into a crop, would be an expenditure of capital without interest.

The operation of freeing a soil from superfluous water is of equal or perhaps more importance than supplying it with manure; because, though without manure plants will not grow with great luxuriance and vigour, yet with too much water they will not grow at all, or will become sickly. The excess of water may proceed from three causes: an extremely moist climate; a soil very retentive of moisture, so as to hold it like a sponge; and, lastly, a soil lying over a subsoil which abounds in springs, or which has the substrata charged with water, which is continually oozing out through the surface soil. The remedy for this last evil is by under drains of considerable depth, so directed as to collect the water from the substrata, and carry it off before allowing it to reach the surface soil.

A soil, after being drained and rendered of a proper texture and composition by the admixture of such earthy ingredients as may be wanting, requires, both for the fertilising effect of atmospheric exposure, and to render it fit for being penetrated by the roots of plants, to be frequently stirred and comminuted. This is done by the mechanical operations of ploughing, harrowing, &c., which, aided by the alternate action of droughts and rains, frosts and thaws, and summer and winter, have the effect of pulverising the soil. To maintain a soil in a fertile state, it is not only necessary to supply it with manure in proportion to the crops which have been carried from it, but to vary the crops which it is made to produce. It has been found from experience that crops of plants belonging to the same natural family do not succeed so well after each other, as when crops of a different family are made to intervene. Thus, the several grasses alternate better with root or herbage crops than with one another; or, one of those grasses of which the seed is ripened, will alternate better with another in which the herbage only constitutes the crop, than with one of the same kind as itself.

Thus, the *principles of Agriculture* may be comprised under the selection of breeds of plants and animals; the improvement of the soil and subsoil; the culture or movement of the soil; the improvement of the local climate by shelter and drying; and the succession of crops. All these principles have been derived from experience; and they are only in part accounted for by chemistry or natural philosophy. They are not, however, on that account, the less true and useful. It is singular that they should all have been known to the Romans, and, to all appearance, almost as fully so as they are to modern cultivators.

The practice of Agriculture in Britain may be included under the heads of the choice, hiring, and stocking of a farm; and its general culture and management. In the choice of a farm in any given country, the object of greatest importance is the nature of the soil; because, though this may be improved by art and expense to such a degree as almost to render a bad soil equal to a good one, yet in practice this would be so expensive as rarely to answer the purpose of the farmer. It may be thought that the vicinity of good roads, of a canal, a railroad, or a market-town, are objects of more importance than the nature of the soil; but this is not the case, because, supposing the roads to be bad, and the market at a distance, it is only necessary to change the system of cultivation and management, and to turn the produce of the farm into some description of live stock which may be driven to a distance, even over a country without roads. If it be alleged that the nature of the climate is of paramount importance to the soil in the choice of a farm, we allow that in an extended sense it is; for example, if a cultivator had the choice of any part of Europe, there are doubtless many districts where the climate is far more favourable for all the operations and products of agriculture than others; and even if he had the choice of every part of Britain, he would find some localities much more favourable than others. In general, however, the actual choice of any cultivator lies within a given locality, where the climate, in a practical point of view, is everywhere the same. Next to soil and climate in the choice of a farm, the state of

the buildings and fences on it, the state of the roads, and the distance from a market-town, are of importance. Without buildings of a sufficient extent, properly situated, and of the proper kinds, the business of a farm cannot be carried on; and in general, fences are as necessary as roads. The last circumstance which we shall mention in this cursory glance is, the nature of the tenure by which the farm is to be held, and the covenants and conditions of the lease. No cultivator, who calculates on the employment of a considerable capital, will risk it on the lands of another without some security for having it returned; and this security is a lease for a fixed number of years. On the other hand, no proprietor of lands will delegate the possession of them to another for a fixed number of years, without a valuable consideration; and this he reserves to himself in the lease, under the denomination of rent. As lands in a state of cultivation, and buildings and fences in a state of repair, are liable to be injured and deteriorated in value by bad management or neglect, the proprietor guards against these accidents by certain conditions in the lease.

The kind of culture and management adopted in any farm depends jointly on the soil and climate; and on the kind of produce most in demand, or reckoned most profitable. In the mountainous districts of Great Britain, where the climate is cold, almost the only kind of farming practised is that of breeding and rearing different kinds of live stock; such as sheep or cattle, which are sold for being fattened in more favourable districts; or horses, in order to supply the demand for these animals for the purposes of draught or for the saddle. The mountainous districts of Scotland and Wales are chiefly devoted to the breeding and rearing of sheep and black cattle; which are sold to the farmers of the low country in both kingdoms, in order to be fattened for the shambles. The hilly districts of Yorkshire and Lancashire are chiefly employed in the breeding and rearing of horses. In the low country of the east coast of Great Britain, the climate, being dry, is favourable for the culture of corn; while on the west coast, and in Ireland generally, the climate, being moist, is more favourable for pasture. The farm products most universally in demand are corn and butcher's meat; and these may be produced on every farm the fields of which admit of being kept alternately in tillage and in grass. The butcher's meat may, however, be produced in much greater abundance on such soils as admit of the culture of root and herbage crops, such as turnips, potatoes, clover, &c.; while corn may be produced most abundantly in strong loamy soils, within reach of extensive sources of manure. The most profitable description of crop will frequently be found to be different from that which is most generally in demand: for example, in the neighbourhood of a large town, the culture of culinary vegetables on a large scale, in what are called farm-gardens, is generally far more profitable than the raising of corn or butcher's meat. Even the raising of food for cattle in such situations is found to yield more profit than common farming. There are also particular crops which may be occasionally cultivated, which yield extraordinary profits; such as plants used in dyeing, or in some specific manufacture; plants of some new and improved variety of the kinds in general cultivation for their seed, &c.

A farm being fixed on, all preliminary matters settled, and the farmer in possession, his first business will be to fix on the general system of cultivation that he means to adopt. In this, as already observed, he will be guided by what the farm is capable of producing, and what he can dispose of. One of the first points that he will determine after this, will be the quantity of land that he can have under each particular kind of crop that he intends to grow; and next, the order in which these crops are to succeed one another. No point, indeed, in the whole system of farm management, is of more importance than the succession, or, as it is usually called, the rotation, of crops. The principle on which the succession of crops is founded has been already hinted at; and in here treating it practically, it may be sufficient to state, that all agricultural crops whatever may be reduced to three kinds—exhausting crops, restoring crops, and cleaning crops; and that the perfection of a rotation consists in always having an exhausting crop followed by a restoring or a cleaning crop; or, what is best, by both combined. All crops which are allowed to ripen their seeds, or which are carried wholly off the ground, are considered exhausting, though in different degrees. Thus, the most exhausting crops in general cultivation are those of corn; but clover, tares, or even hay cut green, are also exhausting, though in a much less degree. Restoring crops are those where the produce is suffered to decay on the ground, or is consumed on it; as in the case of pasture, crops of tares, turnips, &c. Cleaning crops are such as are grown in drills, sufficiently wide to admit of hoeing and other operations of cleaning between. Some of these are at once cleaning and exhausting, as where corn is sown in drills; while others are cleaning and restorative, such as where herbage plants, as clover and lucerne, or roots, as turnips, are drilled, and the plants are to be eaten off on the spot. Other principles which enter into consideration in fixing on a rotation of crops are, that plants which are nearly allied should not succeed each other; because, whether from exhausting the soil of one particular kind of nutriment, or by depositing in it one injurious kind of secretion, certain it is, that the same kind of plants cultivated without intermission on the same soil soon become sickly. Thus three or four crops of any kind of corn in succession will not only unfit the soil for that variety or species of corn, but in a great measure for every other.

The farmer having determined on the crops which he is to grow, and the order of their succession, his next business is to calculate the quantity of *stocking* which will be required for his farm. By stocking is to be understood the number of horses, cattle, and other live stock; and the kind and number of machines, implements, and tools that will be required. In addition to these, he must take into calculation the number of male and female servants which it will be necessary for him to keep, either permanently by the year, or to hire occasionally by the week. Lastly, he will have to take into consideration the sum of money which he will require to lay out for servants' wages, housekeeping, rent, and all other expenses, before he receives any return from his farm produce. The sum total is the amount required for what is called stocking a farm; and it amounts, in different parts of the country, to from 5*l.* to 10*l.* per acre. Poor soil under pasture requires the smallest sum per acre; and rich soil under tillage the largest sum.

The farm being entered on, and the system of culture determined, the future business during the lease is one uniform routine of preparing, sowing, reaping, threshing, and marketing; including, where the breeding or fattening of live stock enters into the system, their purchase, fattening, and sale; or, their rearing, breeding, and sale.

The agriculture of Britain, and especially of the low country of Scotland and the eastern counties of England, excels that of most other countries having similar climates, from the superior skill, intelligence, and capital of the farmer; the considerable length of lease which is granted by the landlord, or the prevalence of a liberal tenant-right agreement; the superiority of the machines and implements employed; and the improved breeds of animals and plants which are reared or cultivated. Perhaps the nearest approach to perfection in the culture of arable land in any part of Britain, is made in some parts of East Lothian, where, in consequence of deep ploughing, substituting under-drains for furrows, regularly supplying manure, and alternating cleaning and restoring crops with exhausting crops, as great an amount of produce is obtained as can stand on the surface at one time. The agriculture of Britain is most defective in the southern and western districts of the island, and wherever the farmers are less wealthy and intelligent and less enterprising, owing to the want or the shortness of leases and to the restrictive clauses in those leases, by which the tenant is prevented from exercising his own judgement and is obliged to follow the routine prescribed in the leases of a former age. The adoption of so-called 'artificial' manuring; the large imports of guano and the enormous manufacture of superphosphate of lime; the extended use of steam power, not only in preparing crops for market, but in the tillage of the land; the adoption of the reaping machine and mower, and that of turnip cutters, chaff cutters, pulping machines, and steamers in the preparation of food for the live stock of the farm, have made a great change in the character of English agriculture since the publication of the first edition of this work.

Agrimonia (Lat.). A wild plant of the Rosaceous family, with saw-edged pinnated leaves, and a long spike of yellow flowers, followed by bur-like fruit. It has had the reputation of keeping old age away from those who persevere in the use of it in decoction. At least, it has the merit of being harmless, and from its slightly tonic qualities it would probably form a good kind of diet drink.

Agrionidae. The name of a family of Neuropterous insects, including the various kinds of dragon-flies (*Libellula* Linn.; *see* that word). The blue dragon-fly (*Agrion puella*) frequents the rushy sides of ditches, and is one of the commonest of the British species of this family.

Agrostemma (Gr. ἀγρός, *a field*, and στέμμα, *a crown*). The name of a few Caryophyllaceous plants, closely related to *Lychnis*, and distinguished by the elongated segments of the calyx-limb, by the absence of scales on the claw of the petals, and by the capsule opening by valves which alternate with the calyx segments. The corn cockle, *A. Githago*, is a representative species.

Agrostis (Gr.). A common genus of grasses, occurring on damp pastures, and dry waste ground. *A. alba*, the marsh bent grass, is the Fiorin grass of agriculturists. In this genus the flowers are single within the glumes.

Agrostology (Gr. ἄγρωστις, *a grass*, and λόγος, *a discourse*). That part of botany which comprehends what relates to the grasses.

Agrypnia (Gr. ἀγρυπνία). In Medicine, the name applied to a state of watchfulness or restlessness.

Ague (Anglo-Sax. eȝe, *shivering*). An intermittent fever, which comes on at certain intervals, leaving the person in the intermediate periods in apparent health. The febrile attacks are often remarkably regular, whence the division of agues into quotidians, which are daily attacks; tertians, which appear every third day, having an intermission of forty-eight hours; and quartans, the intermission of which is about every seventy-two hours. The period during which the fever continues is called the paroxysm or pyrexial period; and the intermission, the apyrexial period. The febrile paroxysm consists of three stages, which follow each other in regular succession; namely, the cold, the hot, and the sweating stage: during the latter, the febrile symptoms abate and disappear.

Ague Cake. An enlargement of the liver or of the spleen produced by the ague.

Aguti. The Indian name of some South American herbivorous Rodent quadrupeds, now included in the genus *Dasyprocta*.

Ahriman, or **Arimanius** (East. theology). One of the chief deities of the ancient Persians. Their philosophers entertained the opinion

subsequently held by the Manicheans, that there were two principles, one of good and one of evil, to the latter of which they gave the name of Ahriman. The two principles were not, however, supposed to be co-eternal or alike powerful; at least such was not the orthodox belief; but it was supposed that in the end, the principle of good, Oromasdes, (Ahuromasda,) would finally prevail over and utterly destroy the principle of evil. (Bayle, arts. ARIMAN, MANICHEENS, and ZOROASTRE; Milman, *History of Christianity*, book iii. ch. v.)

Ai. A word which is a pretty close imitation of the plaintive cry of the three-toed sloth (*Acheus tridactylus* F. Cuv.), of which it is the trivial name.

Aich's Metal. An alloy of iron, copper and zinc, said to be greatly superior to gun-metal in tenacity and ductility. It is also called Sterro Metal.

Aid (Fr. aide, from Lat. adjuvare, *to help*). A pecuniary tribute paid by feudal vassals to their lords in certain cases of emergency. [FEUDAL SYSTEM.]

Aide-de-camp (Fr.). An officer appointed to attend a general officer in the field, in winter-quarters, and in garrison, to receive and carry orders. A field-marshal is entitled to four, a lieutenant-general to two, and a major-general to one. The king appoints as many as he pleases, and this situation gives the rank of colonel.

Aigrette (Fr.) in Botany. [PAPPUS.]

Aikinite. A mineralogical synonym for acicular bismuth. [NEEDLE-ORE.]

Air, *Atmospheric* (Gr. ἀήρ, *air*). The air which surrounds our globe to a height of about forty miles, and which is essential to all living beings, was one of the *elements* of the ancient philosophers: its weight and several of its mechanical properties were discovered by Galileo and Torricelli about the middle of the seventeenth century; but its composition was not accurately determined till more than a century afterwards.

The air is transparent, colourless, inodorous, and tasteless, essential to the respiration of animals and vegetables, and to the support of combustion. It is 816 times lighter than its bulk of water; 1000 cubic inches, at mean temperature and pressure, weighing about 30·5 grains.

The air is a mixture of nitrogen and oxygen gases, with a small portion of carbonic acid gas and of the vapour of water. In particular situations, other substances exist in it; as, over marshes, miasmata; over sulphureous springs, sulphuretted hydrogen; over and near the sea, in dry weather, muriatic acid, either free or combined; and a substance, probably of organic origin, which, aided by light, reddens solution of silver; peculiar organic combinations, sometimes infectious, where people, especially the sick, are confined; sulphurous acid and ammonia, in London and other places where large quantities of coal are burned; and traces of nitric acid during severe thunder storms. A modified condition of oxygen, called *Ozone*, is also occasionally present.

The leading constituents of the air are nitrogen and oxygen, which are to each other in the relative bulks of about 79 and 21, or 80 and 20; and these proportions are probably not liable to any appreciable change, either dependent on season, wind, weather, situation, or height from the surface. Berthollet found 21 per cent. of oxygen in Cairo and in Paris; Saussure, the same in Geneva; De Martyr, in Catalonia, in all winds, weather, seasons, and states of the barometer, in wet and dry, and in inhabited and uninhabited places; Davy, in Bristol and other places in England and upon the coast; also in air brought from the coast of Guinea; Brande, in air from Behring's Straits and from Otaheite: Berger, in the Jura and in the mountains and valleys of Savoy: Configliachi, on the Simplon and Mont Cenis (20·8 of oxygen over rice-fields); Gay Lussac and Humboldt, in Paris, in all seasons and weathers, and at 6,636 mètres above the surface, from 20·9 to 21·5; Dalton, in England, from 20·7 to 20·8: Selden, 21: on January 8, 1835, the barometer being 30·9 inches and a north-east wind, 21·15. In crowded and confined places, the relative proportion of oxygen may be a little below the proper standard, but is soon again restored. Air collected at the back of the upper gallery in Covent Garden theatre, on a full night, gave 20 oxygen, and rendered lime-water more than usually turbid.

The relative proportion of carbonic acid is more variable; yet this gas is found in air from the most elevated regions and purest sources. Saussure and Beauvais found it on the top of Mont Blanc, and in the same proportion in the streets of Paris and at 650 toises above the city. At sea, carbonic acid has sometimes not been discoverable. Saussure found it vary with the seasons, and no doubt vegetation may affect it. In August, over a meadow, the air contained 0·000713, in January, 0·000425. Dalton estimates the mean proportion of carbonic acid at 1 in 1000; Configliachi, the maximum at ·8, and Humboldt at from ·5 to 1·8: this is probably in excess.

The aqueous vapour is the most variable constituent of the atmosphere. It is more abundant with a south and west wind in summer and in warm weather, than with a north and east wind in winter and cold weather. In this climate it usually fluctuates between 1 and 1·5 per cent.

Dr. Prout, (*Bridgewater Treatise*, p. 350), has suggested the possibility of the occasional existence of extremely minute portions of deleterious matters in the air during the prevalence of epidemic disorders; and, in reference to this subject, a remarkable observation occurred during the prevalence of the cholera. For more than six weeks previous to the appearance of cholera in London, he had been almost every day engaged in accurately determining the weight of a given quantity of air under precisely the same circumstances of

temperature and pressure. On February 9, 1832, the sp. gr. of the air suddenly rose above the usual standard, and it continued so for six weeks. On February 9, the wind, which had been west, veered round to the east, and the first cases of epidemic cholera made their appearance.

Without reference to the occasional presence of foreign matters, the average ordinary constitution of the atmosphere may be stated as follows:

	By measure	By weight
Nitrogen	77·50	75·55
Oxygen	21·00	23·32
Aqueous vapour . .	1·42	1·03
Carbonic acid . .	0·08	0·10
	100·00	100·00

AIR. In Music, signifies the *melody*, or most prominent part of a musical composition. In part music it is generally the soprano, or treble. The word, or the Italian, 'Aria,' is also used for a song, or piece for a solo voice.

AIR. In Painting, the medium in nature through which every object is viewed, and hence to be transferred to the imitation on canvass. The effects which it produces are an indispensable part of the knowledge of every artist. It affects the sizes and colour of objects according to their distance.

Air-Bladder. An organ situated in the abdomen of most osseous fishes, which, by altering its dimensions, and the quantity or density of its contents, regulates their relative position to the surface of the water, and is supposed to represent the rudimental condition of the lungs of the higher vertebrates.

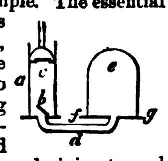
Air-Cells. In Botany, cavities in the stems and leaves of plants, constructed of cellular tissue, and rendering the part in which they reside buoyant in water.

AIR-CELLS. In birds, are membranous receptacles communicating with the lungs, eight of which, of large size, occupy the interspaces of the thoracic and abdominal viscera; the smaller ones extend around the principal joints of the four extremities, penetrate the substance of the bones, insinuate themselves between the skin and subjacent muscles, and enter the quills of the feathers, so that the whole body of the bird is permeated by the atmosphere; whereby its specific gravity is diminished, its respiration extended, its circulation accelerated, and its muscular energies increased, and thus it is finally adapted to wing its way through aerial space. In the flying insects the air-vessels are more or less dilated into air-cells at different parts of their course, in order to diminish the specific gravity of the general mass of the body.

Air-gun. An instrument for projecting bullets or other missiles, the moving power being the elastic force of condensed air. A strong vessel of metal is constructed, into which air is forced by means of a condensing syringe. The air vessel may be of any form, but it is most conveniently disposed of by placing it within the stock. The bullet is placed near the breech, and should fit the barrel very exactly, so as to leave no windage. On pulling the trigger the condensed air escapes through the valve, and rushes with violence into the barrel, propelling the bullet before it; and the instant the finger is withdrawn from the trigger the valve is closed by the pressure of the air in the magazine, which remains in a somewhat less condensed state for the next discharge. Thus the same supply of air in the magazine will serve for several successive discharges, but the force becomes weaker and weaker after each. The force with which a projectile is propelled from an air-gun is much less than that produced by an ordinary charge of gunpowder.

Air-plants. A name given to plants of any kind which grow without their roots penetrating the earth. They have been so called, from its being supposed that they derive their nourishment exclusively from the atmosphere; but as they are usually found in places where they are in contact with at least minute quantities of vegetable matter, or even with the juices of the plants upon which they grow, it is probable that their existence is in part maintained much in the same way as that of other plants. The most extensive natural order in which air-plants are found is *Orchidaceæ*, hundreds of species of which literally crowd the forests of some of the damp and hot parts of the world. Next to these range Bromeliaceous plants, some of which will live for months suspended freely in the air, or tied to iron or stone balconies. Various species of Ficus, and some *Gesneraceæ*, have similar habits.

Air-pump. A pneumatic machine for removing the air out of a vessel. The principle of this instrument is very simple. The essential part of the machine consists of an exhausting syringe (a), closed at one end with the exception of an orifice, to which a valve (b), opening inwards, is attached. An air-tight piston is worked up and



down in the barrel by a rack and pinion turned by a winch. The piston has also an orifice with a valve (c) which opens upwards, or in the same direction as the valve of the barrel. The syringe communicates, by means of a pipe (d), with a vessel (e) called the receiver, from which the air is to be extracted.

The receiver is placed on a brass plate (f,g), and in order that the contact may be air-tight, its ground edge is previously rubbed with a little pomatum.

Suppose the piston at the bottom of the tube. As it begins to be drawn up, the valve c of the piston is immediately shut by the pressure of the exterior atmosphere, so that no air can enter the barrel, and a perfect vacuum would be left under it, were it not that the valve at the bottom of the barrel is forced open by the pressure of the air in the receiver, which rushes into the barrel till its density becomes the same

both in the receiver and barrel. When the piston has been drawn to the top of the barrel, the whole of the air which occupied the barrel has been removed, and the receiver and barrel are now both filled with the air which was previously contained in the receiver alone.

Suppose the capacity of the receiver to be six times that of the barrel, the air which at first occupied six measures now occupies seven, and is consequently reduced to 6-7ths of its former density. Let the piston now be returned to its first position. The instant it begins to descend, the valve *b* shuts, so that no air can enter the receiver. As soon as the piston has descended through one-seventh of the barrel, the air in the barrel is restored to the density of the exterior atmosphere; and as it descends further, the air in the interior of the barrel is condensed, till it acquires an elasticity sufficient to open the valve *c* in the piston, when it rushes out, and continues to do so till the piston has quite returned to the bottom of the barrel. Thus by one stroke of the piston the density of the air in the interior of the receiver is reduced to 6-7ths of its previous density; and it is evident that each succeeding stroke will produce the same effect, or remove 1-7th part of the remaining air. Consequently, after the second stroke, the density of the air in the vessel will be reduced to 6-7ths of 6-7ths = 36-49ths of the exterior air; after the third stroke it will be reduced to 6-7ths of 36-49ths = 216-343rds, and so on. After twenty-one strokes, it will be reduced to about 1-25th of its first density; after one hundred strokes, to 1-5,000,000th part. But so high a degree of rarefaction cannot in practice be obtained; for as soon as the elasticity of the air in the receiver is reduced so far that it has not sufficient force to lift the valves, no more air can escape from the receiver into the tube, and the exhaustion cannot be carried further.

What has now been said applies to all air-pumps, though the form of construction admits of great variety. The better sorts have two exhausting barrels, and the pistons are worked by a rack and pinion, so that when the one piston is ascending in the barrel, the other is descending, by which means an uninterrupted discharge of the air is kept up. The receiver is placed on a smooth plate of brass, having a small hole in the middle to receive the end of a pipe communicating with the syringe. Various contrivances have been employed to continue the exhaustion after the air has been rarefied to that degree that it does not retain sufficient elasticity to lift the valves. In order to determine the degree to which the rarefaction is carried, a barometric tube is adapted to the machine, the upper end of which communicates with the receiver, while the lower end is plunged into an open basin of quicksilver. As the receiver is exhausted, the air is withdrawn from the tube at the same time, and the external air presses up the mercury in the tube to a height proportional to the degree of rarefaction.

This is called a *gauge*; but the following form is more frequently employed. A tube six or eight inches in length, sealed at one end and filled with mercury, is inserted in a basin of the same liquid. The mercury is of course supported by the pressure of the atmosphere, and continues to fill the tube. This apparatus is placed beneath a second receiver, communicating with the pipe *d*. During the first stages of the exhaustion, the mercury still remains supported; but so soon as the tension of the contained air becomes less than is sufficient to support the column of mercury, the liquid begins to fall, and the height at which it stands above the level of that in the basin is the measure of the tension of the remaining air. This is called the short Barometer Gauge.

Otto Guericke, a magistrate of Magdeburg, was the first who conceived the idea of rarefying the air in a vessel by means of a pump, about the year 1654. The machine which he constructed was of a very rude kind, but it enabled him to exhibit experiments which at that time were regarded as astonishing. The air-pump was afterwards greatly improved by Hooke and Boyle; and has attained its present state of perfection through the successive inventions of Hauksbee, Smeaton, Cuthbertson, and others.

Air-vessels. In plants, are minute tubes composed of an exceedingly fine transparent membrane, closed at each end, and furnished internally with a delicate elastic thread twisted spirally, whence they are now commonly called spiral vessels. They occur in the medullary sheath, the veins of leaves and of flowers, in the stamens, the ovary, and the seed: their office is to convey air. In the genus *Nepenthes* spiral vessels are found in the bark and wood in vast quantities.

AIR-VESSELS. In insects the atmospheric air is conveyed through all parts of the body, for the purposes of respiration, chiefly by means of air-vessels, or *tracheæ* (which see).

Aisle (Lat. ala, *a wing*). In Architecture, a term used by the English more especially to signify the side divisions of a church, which are usually separated from the nave or centre portion by pillars or columns. In Egyptian architecture, the Romans denoted by this term the side walls of temples. In that of the Greeks, the *ptera* (a name answering to the Latin *alæ*), were the rows of columns ranged along the sides of temples. The monopteral temples were always circular, the outer wall forming a continuous pedestal for the columns. These buildings had no cella. The peripteral had one row of columns round the cella, the dipteral two; the pseudo-dipteral differed from the peripteral or hexastyle temples in having the side columns moved outwards over the space of one column and intercolumniation, and so had eight columns at each end. The term is also applied to the sides of a building which are subordinate to the principal or central division, and are vulgarly called 'wings.'

Aits. Islets, or little islands, commonly planted with osiers, and which are then called willow aits.

Akenium. [ACHÆNIUM.]

Al Araf (Arab. arafa, *to distinguish*). In Mohammedan Theology, mentioned in the Koran, is interpreted by Mohammedan theologians to mean a kind of limbo, or place of sojourn for those departed spirits which are received neither into Hell nor Paradise.

Ala (Lat. *a wing*). A Roman military term, signifying the wing of an army: but its meaning varied at different times. Denoting at first the body of horsemen who served with the foot soldiers, when the whole legion consisted of Roman citizens, it was applied, after the admission of Socii, whether Latini or Italici, to the troops of the allies, both horse and foot, which were stationed on the wings. At a still later time, the alæ were composed of foreign troops serving with the Roman armies, while under the empire the term was applied to bodies of horsemen raised generally in the provinces and serving apart from the legion.

ALA. In Entomology, the wings, or organs of aërial progression, are tegumentary productions simply, and consist of a double membrane of a tender and generally transparent consistence, inclosing numerous nervures, or branched tubes of a firmer substance.

These organs present considerable differences of form and structure in the different orders of insects, and also vary in number from two to four.

ALA. In Ornithology, the pectoral extremity, the bones of which support broad folds of skin, covered with feathers, and are adapted for flight. The under part of the base of the wing, where it joins the body, is termed the *axilla*; the joint between the antibrachium and carpus is termed the flexure or *plica*. The wing is said to be armed (ala calcarata) when the carpus bears one or two horny spurs; to be impennate (ala impennata) when provided with equal, lax plumes, unfit for flight; to be elongate (ala elongata) when, in the folded state, it equals or exceeds in length the body from the base of the bill to the root of the tail; to be middle-sized (ala mediocris) when, in the folded state, the extremity covers the base of the tail; to be short (ala brevis) when, in the folded state, the extremity reaches the sides of the coccyx.

Alabandine. The name Alabandine was given by Pliny to the Ethiopian Carbuncles which were cut and polished at Alabanda. By modern mineralogists the name is used as a synonym for Manganblende, or Manganese-glance.

Alabarches (Gr.). This name was apparently given to the chief magistrate of the Jews at Alexandria, whose duties lay chiefly in raising and paying the taxes. The word is of very doubtful origin, and many have proposed to substitute the word Arabarches in every place where it occurs. (Smith, *Dictionary of Greek and Roman Antiquities*, s. v.)

Alabaster (Gr. ἀλάβαστρος). The name given to the finest varieties of massive granular Gypsum or sulphate of lime, which bear the same relation to other kinds of Gypsum that marble does to ordinary limestones. The purer kinds are made into statuettes, vases and other ornamental articles, and the commoner sort is converted, by burning, into plaster of Paris. The snow-white translucent Alabaster found at Volterra and Castellina, in Tuscany, is largely manufactured in Florence into works of art, which are exported to all parts of Europe. The alabaster of this country is chiefly met with in the New Red, or Keuper Marl, principally at Ashton-on-Trent, and Chellaston Hill, in Derbyshire, where it is largely worked for ornamental purposes. It is also found in large quantities in Glamorganshire, at Penarth, and other places; at Newark, in Nottinghamshire; Fauld Hill, Tutbury, and near Burton-on-Trent, in Staffordshire; Syston in Leicestershire; Old Chine in Somerset; between Penrith and Carlisle, in Cumberland; and in Monaghan Co., Ireland. [SATIN SPAR.]

Alalite. A mineralogical synonym of Augite and Diopside.

Alamire. In Music, the name of one of the notes in the modern scale of Guido. [MUSIC.]

Alangiaceæ (Alangi, the Malabar name of one species). A natural order of plants closely akin to *Myrtaceæ*. It consists of Indian species, with aromatic roots and eatable fruit. Their long strap-shaped petals afford one of the principal distinctions between them and the Myrtaceous order.

Alanin. A white crystalline substance derived from aldehyd-ammonia, and hydrocyanic acid. Hyponitrous acid converts it into lactic acid.

Alantine. An amylaceous substance extracted from the root of the *Angelica archangelica*.

Alaria (Lat. ala, *a wing*). A genus of sea-weeds found in the colder regions of the North Atlantic and Pacific Oceans. One species, *A. esculenta*, the badderlocks or henware, is found on our own coasts, and is one of the best of the esculent *Algæ*, its midrib and fruit-bearing appendages being the parts most freely used. The name badderlock has been supposed to be a corruption of balderlocks, or locks of Balder, a Scandinavian deity.

Alate (Lat. alatus, *winged*). In Botany, when any solid body is bordered by a membranous or leafy expansion.

Alauda (Lat. *a lark*). The name of a Linnæan genus of passerine birds, characterised by the claw of their hinder toe, which is straight, strong, and longer than the others. The birds of this genus are granivorous, and nidificate on the ground. The field-lark (*Alauda arvensis* L.) is a well-known example: they appertain to the conirostral division of the passerine order of Cuvier.

Alb (Lat. albus, *white*). A vestment, worn by priests in the Roman Catholic church, which differs from the surplice in fitting more closely

to the body, and being tied with a girdle; it is also commonly embroidered on the breast with crosses.

Albarium Opus (Lat.). In ancient Roman Architecture, this term was supposed by some critics to mean nothing but a species of white-wash, but in the passage of the fifth book of Vitruvius, chap. x., where he recommends the use of the *albarium opus* for the ceilings of baths, he allows *tectorium opus* to be used as a substitute for it, so that it was clearly a species of stucco. Its employment at the baths of Agrippa, knowing as we do the extent to which luxury was carried in the baths of the ancients, seems to prove that it was a superior sort of stucco, and it is by no means improbable that it was susceptible of polish. This opinion is propounded by Perrault, in his translation of Vitruvius.

Albata (Lat). The name of a white metallic alloy of brass, with tin or nickel, and sometimes iron. It is largely manufactured at Birmingham, and worked into spoons, forks, dishes, teapots, &c.

Albati (Lat). Christian hermits, so called from the white linen they wore. They lived and slept in the highways. (Hook, *Church Dictionary*, s. v.)

Albatross. [DIOMEDEA.]

Albert Coal, or **Albertite.** A variety of bituminous coal, found at the Albert Mine, Hillsborough Co., New Brunswick. It is of a brilliant and lustrous jet-black, very compact and extremely brittle, breaking with a conchoidal fracture. A thin seam of Albertite has lately been discovered near Mountgerald, in Ross-shire, in strata of Old Red Sandstone age.

Albigenses. (From Alby, a town in the south of France.) A sect which arose in the south of France in the latter half of the twelfth century. They have been confounded with the Waldenses, with whom, however, they do not appear to have had any real connection. Their tenets have been very differently described, and probably misrepresented, by their opponents; and great obscurity is thrown upon the subject, by the fact of the appearance of various dissenters from the church of Rome in England and elsewhere, about the same time, whose respective views have not been very accurately discriminated. It is probable that the reformers of the south of France opposed themselves originally to the corruptions in discipline, which began first at that period to draw general attention and animadversion upon the clerical order. Hence a very easy step would lead them to think slightingly of many ecclesiastical ordinances, and the ceremonial observances of religion would seduce them into the adoption of mystical notions about an internal light and assurance, and finally betray them into the wildest extravagancies. Thus they are charged with perpetuating the Manichean doctrines; but Bossuet, who accuses them of inclining to that system on certain points, acquits them of holding what is, after all, the distinguishing tenet of the Oriental heresy—the monstrous doctrine of the two principles.

In the year 1163, Alexander III. published a decree against these sectarians in a council held at Tours, and another in 1179. On neither occasion, however, did he invoke the assistance of the secular arm. At the close of the century, when the sect was still flourishing, and seemed to be more particularly under the protection of Raymond, count of Toulouse, Innocent III. commenced the work of its extirpation. He appointed two legates to go through the country and excite the zeal of the clergy and laity against the innovators: he instituted the Dominican order of friars, purposely to preach them down; and finally, in 1207, he addressed himself to Philip Augustus, king of France, exhorting him to eradicate the heresy with the sword. The contest or 'crusade,' which was carried on with more or less vigour for many years, and which furnishes the first evidence of the disposition of the church of Rome to employ extreme violence against those who dissented from its doctrines, ended in the entire destruction of the Albigenses, about the middle of the thirteenth century. (Sismondi, *Hist. des Français*, tom. vi.; Milman, *Latin Christianity*, Book ix. ch. 8; Hallam, *Middle Ages*, Part I. ch. i., and Part II. ch. ix.).

Albin. A white opaque variety of Apophyllite, found at Aussig, in Bohemia.

Albinism. A state in which the skin is white, the hair flaxen, and the iris pink. [ALBINO.]

Albino. A term originally applied by the Portuguese to negroes who were born mottled or disfigured with white spots. It is now generally applied to persons of a preternatural whiteness of the skin and hair, with a peculiar redness of the pupil of the eye, which is so weak as to be of little use in broad daylight, so that albinos sleep in the daytime, and are only capable of seeing distinctly in the twilight or by moonlight. The disease appears to depend upon a deficiency or morbid state of the *rete mucosum* over the whole body. Albino races are frequently observed in domestic animals, e. g. in the cat, rabbit, &c. The ferret (*Putorius furo*) is an albino variety of the polecat (*Putorius fœtidus*).

Albite (Lat. albus, *white*). Soda Felspar. A silicate of alumina and soda, in which a small portion of the soda is sometimes replaced by potash and lime. It generally occurs in flat twin-crystals, which vary from translucent to opaque, and are usually white, but sometimes grey, green or brown. It is found in Cornwall, at Ross in Ireland, and in the granite of Slieve Corra (one of the Mourne mountains) it is met with in very perfect white translucent twin-crystals. The principal foreign localities are the Tyrol, St. Gotthard, Arendal in Norway, Greenland, Siberia, Sweden, Bohemia, Oisans in Dauphiny, Massachusetts, &c. Albite is frequently a constituent of granite, and (as in the rocks round Edinburgh) of syenite and

greenstone. When it occurs associated with common Felspar in the same granite, it may be distinguished from the latter by its greater whiteness and translucency.

Albugo (Lat.). A disease of the eye, consisting of a white speck in the cornea.

Album (Lat.). Literally means anything white. The term is now generally applied to a book in which persons collect autographs, literary essays, &c. The prætor's album was a white board, on which the edicts of that functionary were inscribed.

Album Græcum (Lat.). When dogs are fed upon bones, they digest the animal portion, and the earthy parts (chiefly phosphate of lime) are voided in the form of white excrement. This inert matter was formerly used in medicine under the above title.

Albumen. A peculiar organic principle, entering largely into the composition of animal bodies, such as the blood, muscles, membranes, and most of the soft organs, such as the liver, lungs, kidneys, &c; also the chief component of white of egg, to which the term albumen was originally applied, and which well and familiarly illustrates its leading peculiarity, namely, that at a certain temperature it coagulates into a soft white solid, no longer soluble in water. It may be obtained pure by coagulating the white of egg by alcohol, washing it thoroughly with that fluid, and then carefully drying it at 120°. It then appears as a yellow, shining, transparent and brittle substance, composed of—

				per cent.
Nitrogen	1 atom	=	14	15·05
Carbon	8	=	48	51·61
Hydrogen	7	=	7	7·53
Oxygen	3	=	24	25·81
	1		93	100·00

The albumen of birds' eggs (ovalbumen) coagulates at a temperature of 145° to 165°; and when dried, shrinks and becomes brittle and semitransparent, in all respects resembling horn. One hundred parts of the albumen of the hen's egg lose, upon careful drying, about 86 of water, and leave 34 of solid residue. Alcohol, most of the acids, and several metallic salts, also coagulate albumen, and some of the latter are very delicate tests of its presence in animal fluids: subacetate of lead, for instance, renders a solution of 1 part of fresh white of egg in 2000 of water turbid, so that it detects 1 part of dry albumen in 10,000 of water. Corrosive sublimate is also an excellent test of albumen, forming with it a white insoluble compound; hence white of egg has been proposed as an antidote in cases of poisoning by corrosive sublimate. Albumen is a proximate principle of many vegetables, found in their sap and in some of their solid products.

Albumen. In Botany, a floury, fleshy, bony, or horny substance secreted in some seeds between the embryo and the seed-skin. It is intended for the nutriment of the young embryo when it first springs into life. The part that furnishes the flour of corn, the flesh of the cocoa-nut, the great mass of the seeds of coffee, are albumen. Botanists have remarked that this substance is never deleterious, however poisonous the plant may be by which it is borne.

Alburnum (Lat. *sap-wood*). The newly formed and soft part of the wood of Exogenous trees, consisting of empty or nearly empty tubes and cells, the sides of which are thin and not indurated; however durable the timber of a plant may be, this part of it is in all cases perishable, the vegetable matter of which it consists having but little power of adhesion, and being readily decomposed by the action of the air. It is only when the tissue of this part becomes consolidated by the addition of resins, tannin, and various other products, which change its colour from a pale yellow to various other deeper colours, that timber really becomes valuable. In some species this is effected rapidly, as in oak, teak, lignum vitæ, &c.; in others, very slowly, or not at all, as in the poplar and willow. Hence the wood of the latter class of trees never acquires any durability. By some writers the alburnum is defined to be 'wood only one year old.' But this is erroneous. It is through the alburnum principally that the ascending sap of a plant moves; the course of the sap is not, however, confined to the alburnum, but is effected wherever the woody tubes are sufficiently open for it to pass.

Alca. The name of a Linnæan genus of Anserine birds, characterised by a short, compressed, vertically extended, convex beak, edged along the upper surface, and generally transversely furrowed; feet toti-palmate, and wanting the hinder toe. Recent ornithologists have divided the Linnæan auks or penguins into the subgenera Fratercula and Alca.

Alcabala, or **Alcavala.** A tax formerly imposed in Spain and her colonies, consisting originally of 10, and subsequently of 14 per cent. ad valorem, on all property sold, and payable as often as it changed hands. This monstrous impost, by preventing the sale and transfer of property, necessarily proved in the highest degree injurious.

Alcalde, or **Alcaide.** A Spanish officer of justice; from the Arabic kadi, *judge*. In Portugal, Alcayde.

Alcalimeter. A graduated glass tube employed in determining the quantity of real alkali in commercial potash and soda, by the quantity of dilute sulphuric acid of a known strength which a certain weight of these saturates.

Alcamphora. A Brazilian herb, the *Croton perdicipes*, whose leaves are used in decoction against syphilis, and as a diuretic.

Alcantara, Order of: otherwise called the order of Saint Julian, or of the Pear-tree. An order of knighthood, instituted in 1156 at Alcantara, a town of Estramadura, by Hadrian II. king of Leon. The king of Spain is sovereign of this order.

Alcarazza. A porous vessel used in Spain

for cooling water by its transudation and consequent superficial evaporation.

Alcarsin. *Cadet's fuming liquor* or *oxide of cacodyl.* A horribly fœtid liquid formed when acetate of potash and arsenious acid are heated together. It is volatile and intensely poisonous.

Alcedo (Lat.). The name of a Linnæan genus of Picæ, characterised by a long, straight, angular and pointed beak; the tongue and tail very short. The feet have the structure which is the basis of Temminck's order Syndactyli, viz. the external toe is nearly as long as the middle one, and is united thereto as far as the penultimate articulation. The kingfisher, *Alcedo ispida*, is a familiar example of that genus. The *Alcedo tridactyla*, and some others, are remarkable for the absence of the inner toe; these have accordingly been separated from the Linnæan genus under the subgeneric term Ceyx. A third subgenus, Dacelo, receives the great laughing kingfisher of New Holland.

Alchemy. An imaginary art, once much practised among modern nations, and even now perhaps not wholly exploded. The name is a mixture of Greek and Arabic; the last syllables being from the same root with *chemistry*. The prefix is the Arabic article al, *the*. Whether alchemy was followed as an art among the classical ancients, seems questionable: some suppose it to have originated among the Arabs of the Califate. Its object was the production of gold and silver. The principle of the alchemists was, that certain of the baser metals were convertible into these two precious substances by a long series of processes. To this fundamental notion the common followers of the art added an infinity of fantastic imaginations respecting the influence of the planets, &c., in hastening or retarding the work. The instrument by which it was supposed that this mighty change was to be effected, was a certain mineral to be produced by these processes, which, being mixed with the base metal, would transmute it; and this was called the *lapis philosophorum* or philosopher's stone. Hence the term *adept* (adeptus) for him who was supposed to have attained the secret of alchemy; or, in other words, gained or discovered the philosopher's stone. Innumerable instances are on record of persons who practised on the credulity of former times by professing to possess this stone, and who actually wrought the transmutation required; and it is supposed that the philosopher's stone employed by these personages was nothing more than an amalgam of gold, which, if projected into tin and cupellated, would leave a portion of the precious metal. Dr. Price, of Guildford, is said to have been the last person in this country who professed himself able to turn mercury into gold: he destroyed himself in 1782, to avoid, it was supposed, the detection of his deceptions. The alchemists, in the course of their endless experiments, are said to have served the cause of true science in many ways. To various adepts is ascribed the discovery of the concentrated acids and of phosphorus. Another object of the adepts, often pursued by them, together with their research after transmutation, was the discovery of the *elixir vitæ*, or supposed universal medicine. Alchemy is also denominated the Hermetic Art, from the imaginary sage, Hermes Trismegistus.

Alcohol or **Alkohol**, a term of Arabic origin, implying a spirit or essence in its most perfect state. It is retained in modern chemistry to signify pure spirit of wine. Fermented liquors were known in the earliest ages. The Northern nations were probably acquainted with the art of obtaining ardent spirits before the Greeks or Romans. Albucasis in the twelfth century taught the method of procuring alcohol from wine, and Raymond Lully in the thirteenth century concentrated spirit of wine by carbonate of potash.

The elementary composition of alcohol was first accurately demonstrated by Lavoisier, and its analysis was perfected by Saussure. It consists of—

				Per cent.
Carbon .	. 4 atoms	=	24	52·18
Hydrogen	. 6	=	6	13·04
Oxygen .	. 2	=	16	34·78
	1		46	100·00

It may also be regarded as the hydrate of oxide of ethyle, and in that case represented by the rational formula C_4H_5O,HO. [ETHER.]

Pure alcohol has never been frozen; hence its value in the construction of thermometers for measuring temperatures below the freezing point of mercury. It burns with a pale flame, producing carbonic acid and water, and without smoke or soot, forming a cleanly and useful lamp, giving much heat, but little light. It boils at 176°, and the density of its vapour is to that of air as 1·6 to 1·0. Alcohol has an agreeable odour, a strong pungent taste, and is a powerful excitant. The specific gravity of *absolute alcohol* is 0·793 at 60°: that of the *rectified spirit* of commerce is about 0·838, and contains about 16 per cent. of water. What is called *Proof Spirit* has a specific gravity of 0·920, and consists of about 49 parts by weight of absolute alcohol and 51 of water; or by measure of 54 parts of alcohol and 46 of water. When alcohol and water are mixed heat is evolved and condensation ensues, and it is some hours before the two liquids perfectly combine, so as to attain their maximum density.

The strength, or alcoholic value of spirituous liquors, is inferred from their specific gravity, which, for fiscal purposes, is determined by the hydrometer. The following table shows the percentage of alcohol in such mixtures; and in the *Philosophical Transactions* for 1797 will be found an elaborate series of tables founded upon the experiments of Mr. Gilpin and Sir Charles Blagden. Abstracts of these and other similar tables are also given in Ure's *Dictionary of Arts, Manufactures, and Mines*, art. 'Alcohol.' [FERMENTATION; METHYLATED SPIRIT; WINE.]

Sp. Gr. at 60°	Per centage of real Alcohol	Sp. Gr. at 60°	Per centage of real Alcohol	Sp. Gr. at 60°	Per centage of real Alcohol
·9991	0·5	·9511	34	·8769	68
·9981	1	·9490	35	·8745	69
·9965	2	·9470	36	·8721	70
·9947	3	·9452	37	·8696	71
·9930	4	·9434	38	·8672	72
·9914	5	·9416	39	·8649	73
·9898	6	·9396	40	·8625	74
·9884	7	·9376	41	·8603	75
·9869	8	·9356	42	·8581	76
·9855	9	·9335	43	·8557	77
·9841	10	·9314	44	·8533	78
·9828	11	·9292	45	·8508	79
·9815	12	·9270	46	·8483	80
·9802	13	·9249	47	·8459	81
·9789	14	·9228	48	·8434	82
·9778	15	·9206	49	·8408	83
·9766	16	·9184	50	·8382	84
·9753	17	·9160	51	·8357	85
·9741	18	·9135	52	·8331	86
·9728	19	·9113	53	·8305	87
·9716	20	·9090	54	·8279	88
·9704	21	·9069	55	·8254	89
·9691	22	·9047	56	·8228	90
·9678	23	·9025	57	·8199	91
·9665	24	·9001	58	·8172	92
·9652	25	·8979	59	·8145	93
·9638	26	·8956	60	·8118	94
·9623	27	·8932	61	·8089	95
·9609	28	·8908	62	·8061	96
·9593	29	·8886	63	·8031	97
·9578	30	·8863	64	·8001	98
·9560	31	·8840	65	·7969	99
·9544	32	·8816	66	·7938	100
·9528	33	·8793	67		

Alcoholates. Salts in which alcohol appears to replace the water of crystallisation.

Alcoholmeter. An instrument by which the quantity of alcohol contained in wines and other spirituous liquors is determined by reference to their respective boiling points at given pressures.

Alcohols. Substances resembling common vinic alcohol in constitution: chemically speaking they are hydrated oxides of organic radicals.

Alcoran or **Alkoran** (Al Koran, or *the Book*, Arabic). The sacred book of the Mohammedans; which, according to their belief, was dictated to their prophet by the angel Gabriel. The Koran consists of 114 chapters; which are distinguished, not by their numerical order, but by certain titles, under which they are respectively known. Every chapter is divided into smaller portions, analogous to the verses of our Scriptures. There are, however, seven principal ancient copies of the Koran; and in all of these the number of verses is not the same. The Koran is written in what may be termed a species of chiming or jingling prose. It is regarded among the Mohammedans as in itself a standing miracle, and a proof of the truth of their religion; and hence the division between those who believe the Koran to be eternal and uncreated (the Sonnites or orthodox), and various sects of heretics.

Alcornine. A crystallizable substance contained in the alcornoque bark of America.

Alcove (Span. *Alcoba*). In Architecture that part of a sleeping chamber where the bed is placed. In Modern Architecture, the alcoves introduced differ greatly in their manner of decoration, according to the rank or the taste of the proprietor: in England they are rarely used; in France and in Italy they frequently form imposing objects in the decoration of palaces. Generally speaking the alcoves are raised slightly above the floors of the bed rooms, and are roofed at a lower level than that of the latter; they are sometimes separated from the room by a balustrade, through which drapery is passed.

Alcyonites. A collective term for the fruit-like spongiform flint fossils common in chalk formations.

Alcyonium. A Linnæan term for an aggregate genus of marine polypes, having a fleshy coriaceous spicular axis, beset with stellate cells, containing each a polype with eight radiate denticulate arms. The axis is fixed to foreign bodies, and in some species rises in short branches or lobes, as in that commonly known by the name of 'Dead Man's Hand.' (*Alcyonium digitatum* Lin.; *Lobularia digitata* Lam.)

Alcyons (Gr. ἀλκυών, *a kingfisher*). The name given by Temminck to an order of birds of which the kingfisher (*Alcedo*) is the type.

Aldebaran. In Astronomy, the Arabic name of a large and bright star of the first magnitude, called the 'Bull's Eye,' and in catalogues α Tauri, in the eye of the constellation Taurus.

Aldehyde (from *alcohol dehydrogenatus*). A pungent volatile liquid, obtained by distilling alcohol with oxide of manganese and sulphuric acid. Alcohol is a compound of 4 atoms of carbon, 6 of hydrogen, and 2 of oxygen; whereas aldehyde consists of 4 of carbon, 4 of hydrogen, and 2 of oxygen.

Alder (Anglo-Saxon alr). A native tree (*Alnus glutinosa*) belonging to the natural order *Betulaceæ*. It is chiefly found in damp situations, and is of little value except for hurdle wood, and for the manufacture of charcoal.

Alderman. Originally written ealdor-man, meaning elder-man, which was used in the earlier parts of the Saxon period as a name of dignity unconnected with office; it was also the original title of the officer who was subsequently styled earl, whence counties were sometimes called alderman-shires. It seems also to have been the designation of the chief magistrate or judicial functionary of minor districts, in which sense it first appears in connection with boroughs. Its application is now confined to the class of municipal officers in a borough next in order to the mayor. By 5 & 6 W. 4, c. 76, the aldermen are to be in number one-third of the councillors in every borough (London alone being excepted from the provisions of the act), one part to be elected triennially, on November 9, from among councillors or persons qualified to be such; and to form, with the mayor and councillors, the council of the borough.

Aldine Editions. In Bibliography, those which issued from the press of the three

Manutii. Aldo Manuzio was born at Bassiano in the Papal States, and studied in Rome and Florence. He contracted an intimacy with Pico, Count of Mirandola, and with Alberto Pio, Lord of Carpi; and with their assistance set up a printing press at Venice, in 1490. Being a man of great learning and extraordinary zeal in his new profession, he laboured to procure the most correct MSS. of the Greek and Latin classics, and established an academy in his house with the view of obtaining the cooperation of the learned in the superintendence of his works through the press. Bembo and Navagero were among his coadjutors. His first work appeared some time in 1490, but his first dated work in 1494. He was the author of a Greek grammar, a Greek and Latin dictionary (the first of its kind), and many other works. His books have always been prized more for their correctness than for their typographical beauty. They were mostly printed in the duodecimo form. A very rare catalogue of his labours was printed in Venice in 1553 (*Catalog. Librorum Ald.*), and reprinted in Paris in 1709. A complete list is also given in Renouard's *Annales de l'Imprimerie des Aldes, ou Histoire des trois Manuces et de leurs éditions*, Paris, 1803, 2 tom. 8vo., the last edition of which appeared in 1834. The invention of what are now called *italic* types is due to Aldo, who first made use of them in his *Virgil*, printed in 1501. Having observed the many inconveniences resulting from the vast number of abbreviations then in use amongst printers—to such an extent indeed as to render the publication of a treatise on the art of reading a printed book necessary—he hit upon the expedient of using thin italic type, avoiding abbreviations and causing little increase in bulk. These types were for some years afterwards called *Aldine*, but by the Italians themselves *corsivi*. Aldo's son Paolo, a man of learning, an author and a critic, succeeded him in his printing establishment. The family press is said to have been broken up in 1597, although some Venetian publications of the beginning of the seventeenth century are in existence bearing the impress of their colophon (an anchor and dolphin) on the last page.

Ale. [BEER.]

Ale-conners, or -kenners. Those who *ken* or *know* good ale. Ale-conners were annually chosen by the court-leet, and sworn to look at the assize and goodness of the ale and beer in their lordships.

Alectorides (Gr. ἀλέκτωρ, *a cock*). A tribe of rasorial or gallinaceous birds, including the curassow, and the species which, like it, resemble the common fowl in the form of the beak.

Alembic (from the Arabic particle al, *the*, and ambeeg, corrupted from the Greek word ἄμβιξ, *a cup or vessel*). An obsolete form of still: constructed upon a small scale in glass, it is sometimes used in the laboratory.

Alembroth, or Salt of Wisdom. A term applied by the old chemists to a salt composed of sal ammoniac and corrosive sublimate. It is poisonous.

Alexandrian School. An academy for literature and learning of all kinds, instituted at Alexandria by Ptolemy, son of Lagus, and supported by his successors. The grammarians and mathematicians of this school were particularly celebrated. In the former class occur the noted names of Aristarchus, Harpocration, and Aristophanes; and among the latter were numbered the astronomer Ptolemy and geometer Euclid. The grammarians of Alexandria exercised a universal literary jurisdiction, publishing canons of those who were to be considered standard authors, and revised editions of ancient writers. For some account of the famous collection of books at Alexandria, see LIBRARY.

Alexandrine. The French heroic verse of twelve syllables or six iambic feet. In English poetry it is occasionally used: by Dryden, sometimes as a second line in a heroic couplet, more frequently as a third line in a triplet; and the Spenserian stanza necessarily concludes with an Alexandrine. The lines of Pope, defining the Alexandrine by an example, are well known:

> A needless Alexandrine ends the song,
> Which, like a wounded snake, drags its slow length along.

Alexandrite. A variety of Chrysoberyl found in mica-slate, with Beryl and Phenacite, near Ekatherinenberg in the Ural. It was named after Alexander I., emperor of Russia.

Alexipharmic (Gr. ἀλεξιφάρμακος, from ἀλέξω, *I avert*, and φάρμακον, *a poison*). In Medicine, a term applied to things which serve as antidotes to poisons.

Alexiterics (Gr. ἀλέξω, *I avert*). Preservatives against contagious and infectious diseases, and the effects of poisons in general.

Algæ (Lat. alga, *sea-weed*). Plants which are destitute of all signs of sexual organs, and which vegetate exclusively under water. When they grow in salt water they are called sea-weeds, when in fresh water they are named Conferveæ. They comprehend, in the division *Zoospermeæ*, some of the lowest known forms of vegetable life, plants consisting of simple cells adhering in different degrees, and emitting at maturity spores or seeds having a distinct motion. In the case of *Oscillatorias*, the whole mass of the plant writhes and twists spontaneously; and the *Zygnemas* actually copulate. It is in this part of the vegetable kingdom that plants approximate to animals in the most striking degree. A general sketch of this group of plants may be found in Berkeley's *Introduction to Cryptogamic Botany*; an excellent account of the salt-water species in Greville's *Algæ Britannicæ*, and Harvey's *Phycologia Britannica*; and of the fresh-water kinds in such books as the *English Flora*.

Algaroba (Arab. al, *the*, and garoba, *a bean-tree*). A leguminaceous tree found in the southern parts of Europe, and in Palestine,

having pods filled with a sweetish nutritious powder: they are supposed to have been the locusts on which St. John fed in the wilderness. It is the *Ceratonia Siliqua* of botanists. In sandy deserts it is invaluable, because of its roots piercing the soil to such a depth as to be always in contact with water, the effect of which is to maintain perpetual verdure.

Algaroth, Powder of. The white powder which falls when chloride of antimony is dropped into water: it is a compound of chloride and oxide of antimony, virulently purgative and emetic. Named from Algarotti, its discoverer.

Algebra. An important branch of Mathematics, whose name appears to be a contraction of the Arabic phrase *Al jebr e al mokabôlah*, the English equivalent of which would be *restoration* and *reduction*. It is sometimes called a universal arithmetic, but may be more appropriately described as a calculus of symbols. The symbols it employs are of three kinds: (1) those of quantity, known or unknown, which consist of ordinary numbers and letters of the alphabet; (2) those of operation, amongst which are +, −, ×, ÷, √, &c.; and (3) mere abbreviations for ordinary words. [SIGN.] The combination of these symbols according to fixed laws leads to algebraical expressions or formulæ, in which actual computations are indicated rather than performed. The universality of algebra as compared with arithmetic consists in the fact that, in the latter, computations being effected as they arise, all traces of the intermediate steps are obliterated, and the result is applicable to a single case only; whereas, in algebra, the formulæ contain implicitly the answers to an unlimited number of questions. Again, to the equivalence of two algebraical formulæ always corresponds a general theorem, which arithmetic can only *verify* in particular cases. Thus, from the algebraical identity

$$(a+b)\ (a-b)=a^2-b^2,$$

we learn that 'the product of the sum and difference of *any* two numbers is equal to the difference of their squares.'

The systematic notation, to which algebra owes its chief power as an instrument of research, has been of very gradual growth, and is still being extended. In the first known treatise on the subject, by Diophantus, who probably lived in about the fourth century of our era, the few symbols employed are mere abbreviations for ordinary words. The Arabians, who obtained their algebra from the Hindoos, did little or nothing towards its extension, though their treatises, after being carried into Italy by a merchant of Pisa, Leonardo Bonacci (1202 A.D.), gave rise to important improvements. Scipio Ferreus, of Bononia, is said to have solved the first problem of the third degree (1505); but it was Tartaglia, or rather Cardan, who first gave the general solution of a cubic equation, and employed letters to denote the unknown quantities, the *given* ones being still mere numbers. Without extending algebraic notation, Ferrari, a disciple of Cardan, discovered the general solution of a biquadratic equation, and thus, unknown to himself, reached the barrier which, as has since been proved, will ever remain impassable to the searcher for *general* solutions of equations of the fifth and higher degrees. [EQUATION.] Towards the middle of the sixteenth century, algebra was introduced into Germany, France, and England, by Stifelius, Peletarius, and Robert Recorde, respectively. In doing so, our countryman introduced the very convenient symbol of abbreviation =, and Stifelius the far more important symbols of operation +, −, √. In the same century, through her far-famed son Vieta, France contributed still more to the progress of the science. Vieta introduced letters as symbols for known as well as for unknown quantities, and by the increased power thus acquired he laid the foundation of the general theory of equations. In this direction he was followed by Girard, Harriot, Descartes, and others; in short, the science now advanced rapidly towards its present state of perfection. It would be fruitless here to attempt to trace its progress. The reader who wishes to do so may consult with advantage Hutton's *Mathematical Tracts*, vol. ii., Bonnycastle's translation of Bossuet's *Histoire des Mathématiques*, or the *History of Mathematics* by Montucla. The last great improvement in algebraic notation, that of determinants, is of quite recent date. [DETERMINANT.]

Algebraic. An expression or equation is said to be algebraic when it consists of a finite number of terms, each of which involves only the operations of addition, subtraction, multiplication, division, and extraction of *given* roots. Expressions, on the other hand, which contain infinite series or quantities, such as log. x, a^x, sin. x, &c., although, strictly speaking, also algebraic, are distinguished by the term *transcendental*.

Algebraic Curve. A curve whose equation is algebraic. [CURVE.]

Algebraic Geometry. The application of algebra to geometrical investigations. The miscalled *analytical geometry*, whose founder was Descartes, and the characteristic feature of which is the determination of a point by means of coordinates, whose magnitudes are represented by algebraical symbols, is a kind of algebraic geometry, though not the only one. Coordinate geometry would be a more distinctive name for Descartes' invention.

Algerite. An altered variety of Scapolite, found in yellowish to greyish slender square prisms, imbedded in Calc Spar, at Franklin, in New Jersey. Named after Alger, the American mineralogist.

Algodonite. A native compound of arsenic and copper, composed of 83·66 per cent. of copper and 16·34 of arsenic. It is of a brilliant silver-white colour when first found, but it soon tarnishes on exposure to the air. It is met with in small white lumps and veins in the

silver-mine of Algodes, near Coquimbo, in Chili.

Algorithm (an Arabic word, compounded of al, *the*, and the Greek ἀριθμός, number). The art of computing in reference to some particular subject, or in some particular way; as the algorithm of numbers; the algorithm of the differential calculus, &c.

Alguazil (Arab.). A Spanish officer, answering to the English bailiff. His duty is now confined to the apprehension of criminals, but he was in ancient times executioner also.

Alias (Lat. *otherwise*). In Law, when a defendant sued on a specialty, or a prisoner had more than one common appellation, he was designated in the Latin forms of instruments as 'A. alias dictus B.' When it is necessary for a second writ of the same description with a former one to issue, it is headed 'alias,' as, alias capias, &c.

Alibi (Lat. *elsewhere*). A cant Law phrase, used to express the species of defence set up by one charged with a criminal offence, who offers evidence to prove that he was elsewhere at the time when the act was committed.

Alidade. An Arabic name given to the index or ruler which moves about the centre of an astrolabe or quadrant, carrying the sights or telescope, and showing on the limb of the instrument the number of degrees and minutes during which the object observed is elevated above the horizon.

Alien (Lat. alienus, *foreign*). Generally speaking, is one born in a country out of the allegiance of the sovereign, unless his father were a natural-born subject, in which case he will himself be deemed a natural-born subject to all intents and purposes. By 7 & 8 V. c. 66, various statutory disabilities by which aliens were incapacitated from possessing property in England were mitigated; and they are now enabled, on memorialising the home secretary and taking a prescribed oath, to acquire nearly all the rights of natural-born subjects, with the exception that they cannot become members of the privy council, of either house of parliament, or of a municipal corporation. The 10 & 11 V. c. 83, relates to aliens in the British colonies. [Denizen.] Alien Priories were inferior monasteries in England, belonging to foreign abbeys.

Alien Waters. Any stream of water carried across an irrigated field or meadow, but which is not used for the purposes of irrigation; or any waters which are carried through other properties without being made subservient to their uses.

Alienation. In Law, the act of parting with property, more especially real property. The alienation of real property takes place by deed, or in pais. [Real Property.]

Alignment. (Fr. alignement.) A Naval term for a supposed line drawn to preserve a fleet in position.

Alimentary Canal. A cavity in the interior of an animal body in which the nutriment is taken to be digested, before it is conveyed by the nutritive vessels to the system: it affords the best organic characteristic of an animal, but presents various modifications of structure. Sometimes it is a simple cavity with one opening; sometimes a true canal with an outlet or anus, distinct from the inlet or mouth; this canal may be divided into stomach and intestine, as in the oyster; or a mouth, pharynx, and œsophagus may precede the stomach; the œsophagus, again, may have one or two sacculi appended to it, called crops. The stomach may be subdivided into four bags, as in the Ruminants, or into seven, as in the bottle-nose whale; and the intestines into small, blind, and large, forming, with their subdivisions, what are termed duodenum, jejunum, ileum, cæcum, colon, and rectum. The cæcum, again, may be single, or double as in most birds; or a single cæcum may exist in addition to a double one, as in the Hyrax, a small Pachydermatous quadruped. Lastly, the various glandular organs which communicate with the alimentary canal are to be regarded as cæcal processes of that tube, since these are developed from it, and in this condition they are permanently retained by one or other of the lower animals: thus, in the sea mouse, the liver is represented by long, branched, lateral processes of the intestine; in the cod fish, &c., the pancreas is similarly represented by numerous cæcal processes of the duodenum.

Alimony (Lat. alimonium, *sustenance*). In Law, the allowance for which a married woman is entitled to sue on separation from her husband. [Marriage.]

Aliquot Part. A number which divides a given number without leaving a remainder; in other words, a *measure* or *divisor*. Thus, 2, 3, 4, and 6 are aliquot parts of 12, being contained in the latter 6, 4, 3, and 2 times exactly. The term is principally employed in the arithmetical rule of practice. [Practice.]

Alismaceæ (from the Greek ἄλισμα). A small natural order of Endogenous plants, marked by the presence of numerous distinct carpels in a tripetaloideous flower. They form a near approach to the *Ranunculaceæ* among Exogens. *Alisma* and *Sagittaria* are the most common genera.

Alisonite. A double sulphide of copper and lead, composed of 53·34 per cent. of copper, 28·88 lead, and 17·78 sulphur. It occurs massive at Mina Grande, near Coquimbo, in Chili, of a deep indigo-blue colour, which quickly tarnishes on exposure. Named after R. E. Alison.

Ali-trunck, Alitruncus. In Entomology, the posterior segment of the thorax of an insect to which the abdomen is affixed, and which bears the legs, properly so called, or the two posterior pairs, and the wings.

Alizarine. From Ali-zari, the commercial name of madder in the Levant; a peculiar colouring principle obtained from madder.

Alkahest. A term of Arabic origin, applied by the alchemists to a supposed universal solvent.

Alkali, or **Alcali.** Derived from the

Arabic article *al*, and *kali*, the name of a plant in the same language. A term originally applied to the ashes of plants, now generally used to designate potash, soda, and ammonia, which are also termed vegetable, mineral, and volatile alkali. These substances have certain properties in common, such as neutralising and forming salts with the acids, reddening several vegetable yellows, and changing some blues to green, and ready solubility in water. Lime, baryta, strontia, and magnesia, have been called alkaline earths, from their analogous action on vegetable colours. Lithia is also one of the alkalis. A singular class of bodies have been discovered in vegetables, which have been termed *alkaloids*, chiefly in consequence of their power of saturating and forming definite salts with the acids. Morphia, quinia, &c., are substances of this description.

Alkali, Fossil or Mineral. [Soda.]

Alkali, Phlogisticated. [Ferrocyanide of Potassium.]

Alkali, Vegetable. [Potash.]

Alkali, Volatile. [Ammonia.]

Alkalimetry. The process of measuring or estimating the amount of alkali in a specimen of carbonate or caustic potash, or soda, of unknown strength. It is generally accomplished by exactly neutralising such a quantity of pure and dry carbonate of soda as contains exactly one hundred grains of real alkali, with diluted oil of vitriol. A volume of the acid, equal to that used in the experiment, is then farther diluted till it fills a tall narrow glass cylinder divided into one hundred parts. A large quantity of acid being thus prepared, one part or measure of which is equal to one grain of real alkali, it follows that the number of measures of acid used in exactly neutralising one hundred grains of impure carbonate of soda will be the number of grains of real alkali in that crude specimen. The standard acid once prepared, this process of determining percentage values is a very ready one.

Alkaloids. Substances analogous to alkaline bases, but of vegetable origin, and generally possessed of great medicinal activity. Their ultimate elements are carbon, hydrogen, oxygen, and nitrogen. The principal substances of this class, together with the plants from which they are obtained, are the following:—

Aconita . . .	Aconitum napellus
Aricina . . .	A bark from Arica
Atropia . . .	Atropa belladonna
Brucia . . .	Strychnos nux vomica
Cinchonia . .	Cinchona lancifolia
Codeia . . .	Opium
Conia . . .	Conium maculatum
Corydalia . .	Corydalis tuberosa
Cynapia . . .	Æthusa cynapium
Daturia . . .	Datura stramonium
Delphia . . .	Delphinium staphisagria
Digitalia . .	Digitalis purpurea
Emetina . . .	Cephaelis ipecacuanha
Hyoscyamia . .	Hyoscyamus niger
Meconia . . .	Opium
Morphia . . .	Opium
Narcotina . .	Opium
Nicotina . . .	Nicotiana tabacum
Picrotoxia . .	Menispermum cocculus
Quinia . . .	Cinchona cordifolia
Sanguinaria . .	Sanguinaria canadensis
Solania . . .	Solanum nigrum
Strychnia . . .	Strychnos nux vomica
Thebaia and Narceia	Opium
Veratria . . .	Veratrum sabadilla.

Alkanet (a corruption of the French *orcanette*). A reddish-purple dye, obtained from the roots of *Anchusa tinctoria*. The root of this plant, which is a native of the warmer parts of Europe, contains a red resinous colouring matter which it imparts to alcohol and oils: it is used to tinge some ointments, especially lip-salves, of a red colour.

Alkarsine. A compound of carbon, hydrogen, oxygen, and arsenic; it was formerly called *Cadet's fuming liquor of arsenic*; it is the *oxide of kakodyle* of modern chemistry. [Kakodyle.]

Alkermes. An old pharmaceutical preparation coloured with kermes, resembling the modern *aromatic confection*.

Alkool. A preparation of antimony used by the women of eastern nations to tinge the eyelids and lashes of a black colour. Dr. Shaw, speaking of the women in Barbary, says, 'None of these consider themselves dressed till they have tinged the edges of their eyelids with alkool.'

Alla Breve (Ital. *according to the breve*). In Music, the name of a movement each of whose bars or measures consists of the note called a breve, equal therefore to two semibreves or four minims. It is denoted at the beginning of a staff by a C with a bar drawn through it vertically: thus, ₵.

Alla Capella (Ital.). In Music, the same as Alla Breve. The name originates in the circumstance of this time having been principally employed for movements used in the church or chapel.

Allagite (Gr. ἀλλαγή, *change*). A variety of Rhodonite, of a greenish-grey colour, verging upon black, found in the vicinity of Rubeland in the Harz. The name is in allusion to the change of colour which it undergoes on exposure.

Allah. The Arabic name of the Supreme Being. It signifies the True God, as opposed to the deities of idolaters.

Allanite. A silico-ferriferous oxide of Cerium and Lanthanum, named after the late Mr. Allan, of Edinburgh, by whom it was first recognised as a distinct species.

Allantoic Acid. A white crystallizable acid, obtained by evaporating the allantoic liquid of the fœtal calf.

Allantoine. The substance originally termed *Allantoic acid*. It has been produced artificially by the action of peroxide of lead on uric acid: its formula is $C_4H_3O_3N_2$.

Allantois (Gr. ἀλλᾶς, *a sausage*, and εἶδος, *form*). A thin membranous sac developed from the termination of the alimentary canal

of the embryo, situated between the amnion and chorion, and organised by the hypogastric arteries and umbilical vein. Its function, as a temporary respiratory organ, is of most importance in those oviparous Vertebrates where the embryo has no branchiæ; in the Mammalia, its use is more or less superseded by the chorion and placenta. In some quadrupeds the allantois has the form of a sausage; whence its name.

Allanturic Acid. A product of the action of heat on allantoin.

Alleghanies. The part of the Appalachian chain of Eastern North America which crosses Virginia and Pennsylvania. The chain is 150 miles long, and includes several very narrow ridges of moderate elevation between which are narrow valleys. The parallelism of the ridges and valleys is very remarkable and characteristic. [APPALACHIAN CHAIN.]

Allegiance (Fr. allégeance, from the Latin alligare, *to bind*). The obedience which a citizen owes to his prince or country. The allegiance of a born subject of the English crown is inseparable, and follows him everywhere: nor can he by any act of his own free himself from it. There is also a temporary allegiance, which foreigners incur so long as they reside within the king's dominions. By common law, all persons above the age of twelve years were required to take the oath of allegiance at the court leet; and the oaths of allegiance and supremacy have since been imposed by many statutes. The present form of the oath of allegiance was introduced by the Convention Parliament of 1688. A single oath was substituted for those of allegiance, supremacy, and abjuration, in 1858, by 21 & 22 Vict. c. 48. The American laws require a foreigner to have renounced (as far as possible by his own act) allegiance to his former government two years before he takes the oath of allegiance to that of his acquired country.

Allegory (Gr. ἀλληγορία). In Rhetoric and Literature, has been defined, 'a figurative representation, in which the signs (words or forms) signify something beyond their literal or direct meaning.' In this sense allegory may be addressed to the eye, in painting and sculpture, by means of forms intended to convey, besides the notion of those sensible objects which they represent, certain abstract ideas to which these objects are supposed to bear analogy. Allegory differs, 1. from symbolical writing or representation; because in the first, the type and antitype, or thing exhibited and thing intended, have some real or natural resemblance, relation, or analogy: in the latter, the resemblance is merely conventional. Thus, to take an instance from modern literature: if it be true, as is now alleged, that the earlier Italian poets of the middle ages, and Dante in particular, attached a conventional meaning to certain ideas frequently recurring in their poems; as, for example, that Satan signified the papal power,—the three beasts mentioned in the commencement of Dante's poem three states—love, loyalty to the emperor, &c. &c.; then their poems, considered with reference to this occult sense, must be regarded as specimens not of allegory but of symbolical writing. But if, as in the more ordinary interpretation of Dante's poem, Satan represents the abstract idea of eternal misery, the beasts particular vices, &c., which in common acceptation are supposed to have some natural analogy with their representatives, the poem is in this respect to be regarded as an allegory. Thus, also, critics have endeavoured to give a symbolical sense to the sixth book of Virgil's *Æneid*; while, independently of that sense, if it really exist, there is an obvious allegorical meaning running through the whole. (In ancient criticism, however, the words allegory and symbol were not so accurately distinguished; and in our translation of the Bible, St. Paul is made to use the word allegory in the clear sense of type, Gal. iv. 24.) Allegory differs, 2, from parable, only inasmuch as the latter is a species of the former; a parable being a short sententious allegorical narration. And, 3, it is different from metaphor, being in effect a chain of metaphors, or a single metaphor continued and wrought out into a lengthened discourse. 4. Fables may also be mentioned as a species of allegory. [FABLE.] An allegory, or allegorical tale, in the somewhat narrower sense in which the term is used in literature, is generally a tale in which abstract ideas are personified: such (to cite one of the earliest instances of this species of composition) as the *Choice of Hercules*, between virtue and vice, in the shape of two females: an allegory which descends to us from the Athenian sophist Prodicus. Entire poems are sometimes strictly allegorical, as that of Spenser; or entire narratives, as Bunyan's *Pilgrim's Progress*; in which case it requires consummate art to keep up the propriety of the allegory, which is in fact a compound of two opposite, and sometimes scarcely compatible, qualities — consistency running through its several incidents, when considered merely as a narrative and without reference to the ulterior meaning, and consistency of analogy between the thing represented and the thing indicated.

Allegretto, and **Allegro** (Ital. *a little merry*, and *merry*). In Music, the first term is a diminutive of the second, which, prefixed to a movement, signifies that it is to be performed in a brisk and lively manner; not, however, with hurry or precipitation. [TIME.]

Allemontite. A mineralogical synonym for the arsenical antimony found at Allemont in Dauphiny.

All-hallows. The old English name for All Saints' day (the 1st of November).

Alliaceous Plants. Plants which partake more or less of the qualities of garlic and onions; such as onions, shallots, rocambole, chives, leeks, garlic, &c.

Alliance. In Politics and International Law, a league between two or more friendly powers; which may be either offensive and

defensive, or defensive only. Of the former species is the alliance of 1813 against Napoleon, subsequently called the Holy Alliance; and that of 1854 between England, France, and Turkey, against Russia; of the latter, the Quadruple Alliance, concluded in 1833 between England, France, Spain, and Portugal. Alliances are divided by publicists into three classes: 1. Those in which the allied parties agree to prosecute a war with their whole force. 2. Alliances in which auxiliary states pledge themselves to grant to a principal state a fixed contingent of men, money, &c. 3. Such as are constituted by treaties to furnish troops for stated subsidies, to make advances of money, &c.

Alligation (Lat. alligatio, from alligo, *I bind together*). A rule of Arithmetic, for the solution of questions concerning the compounding or mixing together of different ingredients, or ingredients of different qualities. There are two cases, one of which is alligation *medial*, and the other alligation *alternate*. To the first case belongs a question of this sort: Suppose 4 gallons of wine, at 12*s*. per gallon, to be mixed with 6 gallons at 17*s*. per gallon, what is the worth of a gallon of the mixture? But if it were asked, in what proportions wines, at 17*s*. and at 12*s*. per gallon respectively, must be mixed in order that the value of a gallon of the mixture may be 15*s*., the question would belong to alligation alternate. Questions of this kind are most easily resolved by algebra; they belong, in fact, to a class of indeterminate problems, admitting in general of an indefinite number of solutions. [INDETERMINATE ANALYSIS.]

Alligator (a corruption of the Portuguese word 'lagarto,' which is derived from lacerta, *a lizard*). In modern Zoology, the term is limited to those species of crocodile which have a wide obtuse muzzle, unequal teeth, the fourth pair of which, counting backwards in the lower jaw, pass into corresponding cavities in the upper jaw, where their points are concealed when the mouth is closed. In the true crocodiles, the corresponding teeth pass into open grooves in the margin of the upper jaw, and are consequently exposed. In the alligators the head is less oblong, its length being generally to its breadth as 3 to 2: the teeth are more numerous than in the crocodiles, sometimes amounting to twenty-two in the lower jaw, and to twenty in the upper. The hind legs and feet are rounded, and have neither crests nor dentations; the interspaces of the toes are only occupied for half their extent by a short membrane. The alligators, so far as is yet known, are peculiar to the New World.

Alliteration. In Composition, the frequent recurrence of the same letter, chiefly at the commencement of different words. This is sometimes resorted to, especially in poetry, for the production of effect. In the Celtic languages, alliteration was a recognised ornament in versification: it was so likewise in the early Gothic tongues; and in old English there are entire poems composed in alliterative metre, of which the celebrated *Vision of Piers Ploughman* is the most remarkable. The use of it did not wholly disappear until the middle of the 16th century.

Alliturie Acid. One of the bodies formed when alloxan is boiled with hydrochloric acid.

Allium (Lat.) A genus of Liliaceous plants, consisting for the most part of bulbous-stemmed species, and including the onion, *A. cepa*, leek, *A. Porrum*, garlic, *A. sativum*, shallot, *A. ascalonicum*, chives, *A. Schœnoprasum*, and other onion-flavoured plants cultivated as condiments. It comprises numerous species, some of which are sufficiently ornamental to be cultivated for the sake of their flowers. They may be known amongst Endogenous plants by their odour. Of the species employed in medicine, the leek, the onion, and the garlic, the latter is the most active, as it is the most strongly flavoured.

Allocation. In Law, the allowance of an account in the Exchequer. The writ *de allocatione facienda* is for allowing an accountant sums expended by him in his office. The certificate of allowance of costs of taxation granted by the master, prothonotary, or other officer of court, is termed in practice an *allocatur*.

Allochroite. A massive variety of Iron-garnet, which derives its name (Gr. ἄλλος, *another*, χροία, *colour*) from the various colours it exhibits when melted before the blowpipe with phosphate of soda.

Allocution (Lat. *adlocutio*). A name given to certain addresses made by the pope to the cardinals.

Allodium. In Feudal Law, a word of uncertain derivation (see Wedgwood's *Dictionary of English Etymology*, s. v.; Hallam's *Middle Ages*, ch. ii. part i. note *h*). Land held by an individual in his own absolute right, discharged of all feudal obligation; opposed, therefore, to fee, fief, or feud. No allodial property can exist in England, where the king, in the eye of the law, is lord paramount of all lands and hereditaments. In ancient France the rule was, 'nulle terre sans seigneur,' and the presumption was in some parts of that country always in favour of a fief, unless the land were shown to be allodial. In Germany, on the contrary, the legal presumption was in favour of the allodium.

Allomerism. Constancy of crystalline form under variation in proportion of the constituents of a crystalline compound. Thus, an alloy of zinc and antimony containing 36 per cent. of the latter metal crystallizes in needles which do not vary in angular measurement though the antimony be increased 20 per cent.

Allomorphite (Gr. ἄλλος, *other*, and μορφή, *form*). A variety of sulphate of baryta found in scaly masses near Rudoldstadt, in Schwarzburg.

Allopathy (Gr. ἄλλος, *different*, and πάθος, *disease*). A term recently invented to describe the ordinary system of medical practice in opposition to *Homœopathy* [which see].

Allophane (Gr. ἀλλοφανής, from ἄλλος, *other*, and φαίνομαι, *to seem*). A hydrated silicate of alumina, composed of 24·22 per cent. of silica, 40·39 alumina, and 35·39 water. It usually occurs lining small cavities and forming veins in marl or chalk; sometimes in little reniform masses with a resinous or waxy lustre, and of a pale blue colour, but occasionally green, brown, yellow, or colourless; translucent, and very brittle. It is found in the chalk-pits at New Charlton, near Woolwich, and abundantly in the chalk of Beauvais, in France; also in Saxony, Moravia, Bohemia, &c. The name has reference to its change of appearance before the blowpipe.

Allophanic Acid. An acid formed by passing the vapour of cyanic acid into alcohol: its chemical formula is $C_4H_3O_8N_2$.

Allotment of Lands. Any piece of land set apart or allotted for any particular purpose. When more land is laid to a cottage than suffices for a garden, it is commonly called a cottage allotment.

Allotropy (Gr. ἀλλοτροπέω, *to be changeable*). A term used to designate the property (belonging to certain substances) of exhibiting variable characters at different temperatures, especially as relates to *colour, texture, solubility*, &c.: thus sulphur is usually yellow and brittle; but if fused at a high temperature, and poured into water, it becomes brown and viscid. The characters of phosphorus are also remarkably changed by temperature.

Alloxan. One of the products of the action of nitric acid on uric acid: it is a colourless crystalline substance, the aqueous solution of which tinges the cuticle purple: its chemical formula is $C_8H_4O_{10}N_2$.

Alloxanic Acid. A substance derived from alloxan by the action of caustic baryta and heat.

Alloy (from the French à loi, *according to law*, i.e. the law by which the composition of money is governed). The name given to the compounds of the more precious metals with others of less value; or to the less valuable of the metals in such compounds; thus, gold is said to be alloyed with silver, silver to be alloyed with copper. Chemists apply the term to all combinations obtained by fusing together metals: thus, brass is an alloy of copper and zinc; bronze, of copper and tin: when mercury is employed, the result is called an *amalgam*. Many of the alloys are extensively used in the arts, for they present characteristics which the pure metals do not possess; as, for instance, gold and silver, in their pure state, are too soft and flexible to allow of their being worked into plate, jewels, coin, &c., until they are hardened by the presence of a certain portion of copper, whilst their colour and other valuable properties are not materially impaired by the addition.

It has been found that the alloys of some metals present anomalous conditions, as for instance that they are greater, or less, than the mean of their compounds in specific gravity; indicating that in some cases they have expanded, and in others contracted. Their fusion point may also be greater or less than that of their mean composition; and it is at all times difficult to secure a mass which is of the same composition throughout. Some of the alloys are crystallizable, and are probably definite or atomic.

Allspice. The immature berry of Jamaica pepper (*Myrtus pimenta*). It has the combined flavour of nutmeg, cinnamon, and clove.

Alluaudite. A hydrated double phosphate of soda, protoxide of manganese, and peroxide of iron, found in France, at Chanteloupe, near Limoges, in subtranslucent and opaque masses of a clove-brown colour. Named after M. Alluaud.

Allusion (Lat. adlusio, from ad, *to*, and ludo, *I play*). In Rhetoric, strictly, a covert indication, as by means of a metaphor, a play of words, &c., of something not openly mentioned, and extrinsic to the principal meaning of the sentence.

Alluvial Deposit. A deposit of river-mud or silt. The term is generally limited to mud or silt conveyed by the ordinary current of a river from higher land to a plain, and there left behind, owing to diminished rate of motion of the water.

The remains of land animals of various kinds common on the banks of streams, and the leaves and twigs of plants growing in such localities, are often preserved in these deposits.

Alluvium. (Lat.) The mud or silt washed from the surface of land by rain into the ordinary streams of a country, and conveyed by them to the plains, where it is quietly deposited. Alluvium is a word used in contradistinction to *diluvium* [which see]. There is no limit to the age of alluvium, but we are only familiar with deposits of this kind recently made.

The literal meaning of alluvium (from the Latin *alluo*, to wash upon, or *alluvio*, an inundation) would refer to a limitation to those materials deposited on land not permanently submerged but merely washed over by water. This limitation is not always strictly adhered to, as the bed of a large river must be regarded as permanently submerged, and is yet composed of alluvial mud.

Allyle (Lat. allium, *garlic*). A hydrocarbon (C_6H_5) supposed to constitute the basis of the volatile oil of garlic.

Almagest. A name given by the Arabs to the celebrated work of Ptolemy, the astronomer of Alexandria: it signifies the greatest work, from the Arabic al, *the*, and the Greek μέγιστος, *greatest*. The best edition of this work is that of Paris, 1813-15, two vols. 4to., Greek and French, by M. Halma.

Almagrerite. Native anhydrous sulphate of zinc, found in Spain, at the Barranco Jaroso Mine in the Sierra Almagrera, in crystals which are isomorphous with sulphate of baryta.

Almacantar (from the Arabic). A term used by the old astronomers to denote a small circle of the sphere parallel to the horizon.

Almanack (probably from the Arabic al Manack, *the diary*). An annual publication containing a calendar of the days and months of the year, the ecclesiastical feasts, the time of the sun's rising and setting, the age of the moon, and the solar and lunar eclipses. To these are frequently added information on various subjects of astronomy, chronology, meteorology, the tides, statistics, lists of post-offices, public institutions, &c., according to the views or fancy of their respective authors. Almanacks correspond in some respects to the Fasti of the Romans, and are of very ancient date. The Greeks of Alexandria constructed them about the time of Ptolemy; but the earliest of which Lalande could obtain any notice was that of Solomon ben Isaac Jarchi, published about 1150, and that of the celebrated George Purbach, published from 1450 to the time of his death in 1461. The first printed almanack appeared in 1474, and was drawn up by Regiomontanus, nearly, at least so far as regards the calendar, in the form now used. Till within a few years the numerous almanacks published in England were little creditable to the taste or morals of the country. They had for a long time been monopolised by the Universities and the Stationers' Company, under charter granted by James I., and under their patronage astrology flourished till late in the last century, notwithstanding the attacks of Swift under the assumed name of Isaac Bickerstaff. The Stationers' Company appear to have acted merely on the commercial principle of publishing that which pays; for we find, in 1624, that while they continued their astrological and other predictions in one almanack, they published at the same time another by Allstree, calling the supposed influence of the moon upon the different members of the body 'heathenish,' and dissuading from astrology in doggrel verse. The prognostics connected with St. Swithin's day (July 15) have kept the firmest hold upon the popular mind.

The monopoly enjoyed by the Stationers' Company was at length broken through by Thomas Carnan, a bookseller, who had detected some illegality in the exclusive right of the Stationers' Company, and invaded it accordingly. This occurred in 1775. In 1779 Lord North brought in a bill to renew the privilege, but, after an able argument by Erskine, it was thrown out. The *British Almanack*, the first purely unexceptionable work of the kind, was published in 1828 by the Society for the Diffusion of Useful Knowledge; and it induced the Stationers' Company also to issue a good one, the *Englishman's Almanack*. The removal of the heavy stamp duty of fifteenpence per copy, to which they were subjected till 1834 (3 & 4 Will. IV. c. 57), has been attended with all the advantages which usually result from the exercise of free competition. The average number of stamps issued between 1821 and 1830, inclusive, was about 499,000 yearly, producing an average revenue of about £31,000. About 200 new almanacks were published as soon as the duty was repealed, and of some of these upwards of 250,000 copies were sold.

The *Nautical Almanack* is published by order of the Board of Admiralty, for the use of both astronomers and seamen, and contains a copious list of astronomical phenomena, and of the elements which are used in finding the longitude at sea. This work is also a very complete astronomical ephemeris, showing the instants of time at which the planets and principal stars pass daily the meridian of Greenwich; the sun's right ascension, and the logarithms of his distances; the moon's place at intervals of three hours, &c. This valuable work first appeared in 1767, under the superintendence of Dr. Maskelyne, then astronomer royal, and was continued by him for forty years. From his death till 1834 the almanack continued to decline in value; but in that year certain alterations proposed by the Astronomical Society were adopted by the government, and a new era in its existence was begun. The oldest nautical almanack in Europe is the French *Connoissance de Tems*, commenced by Picard in 1679.

By the law of England, the only almanack of which cognisance is taken by the Courts of Law is that annexed to the Book of Common Prayer.

Almandine, or Almandine Garnet. The name given to red, transparent varieties of Garnet. It is composed of 36·3 per cent. of silica, 20·5 alumina, and 43·2 protoxide of iron. It occurs in rhombic dodecahedrons, the edges of which are sometimes replaced by six-sided planes, in Ceylon, Pegu, Hindostan, Brazil, and Greenland; also at Elie in Fifeshire, Ala in Piedmont, and in various parts of Bohemia. When transparent and of good colour, this stone is used in jewelry, under the name of Bohemian or Precious Garnet.

Almery. An old term for Ambry, or Aumbry, the designation of a niche formed in a wall by the side of an altar, to contain the instruments belonging thereto, together with the host, holy oil, and chrysmatory. The term is also applied to closets with shelves, buffets, &c., wherein plate, relics, vestments, deeds, &c., were kept: they were usually of large size, and were profusely decorated.

Almond (Gr. ἀμύγδαλον, Fr. amande). The seed or kernel of the *Amygdalus communis*. Sweet almonds afford, in the 100 parts, 54 of fixed oil, 24 of albuminous matter, 9 gum and sugar, 4 woody fibre, 5 husk, and 4 water and loss. They afford neither volatile oil nor prussic acid when distilled with water. Bitter almonds contain less fixed oil, and a peculiar principle termed *Amygdalin*. When bitter almonds are cold pressed, the oil which exudes contains no trace of prussic acid; when hot pressed, its flavour may be perceived: the cake remaining after pressure yields a volatile oil by distillation, the quantity and strength of which in prussic acid are variable. The distilled or volatile oil of bitter almonds is about the specific gravity of water; that which passes

first over is most poisonous. It changes when exposed to air, and forms benzoic acid: in close vessels it may be long kept without deterioration. When used in medicine, great care is requisite on account of its varying strength. The distilled oil of peach leaves and of the cherry laurel also contain prussic acid, and consequently the water distilled from them is poisonous.

Almoner. An officer in a religious house, to whom the distribution of alms was committed. The term is still retained by officers in some of our hospitals.

Alms (A. S. Aelmeꝛꝛe). Charitable offerings, from the Greek ἐλεημοσύνη, *pity*, which came in the early ages of the church to be used in the plural number in the peculiar sense which is represented in our language by the word Alms.

Alnager, or **Aulnager.** An ancient English sworn officer, appointed to examine into the assize of cloth, fix seals to it, and collect the alnage duty on all cloths sold (25 Edw. 3, stat. 4, c. 1). These duties were abolished in England by 11 & 12 W. 3, c. 20, and in Ireland by 57 Geo. 3, c. 109. (Wharton, *Law Lex.* s. v.)

Aloe (Gr. ἀλόη). A small genus of *Liliaceæ* with endogenous stems, and stiff fleshy juicy hard-pointed leaves, which in some species abound in a purgative principle obtained by simple pressure of the bruised leaves. The juice when inspissated becomes the medicinal drug of the shops.

Aloes. The inspissated juice or extract of several species of aloe. This article is largely imported for medical use from Bombay. It is of a brown colour, a peculiar and somewhat aromatic odour, and a nauseous and intensely bitter flavour: it consists of extractive and resin, and is nearly soluble in boiling water, but the solution as it cools deposits flakes of resin. The best aloes were formerly brought from the island of Socotorah, in the Indian Sea, and hence all the finer aloes of commerce are frequently termed Socotorine aloes. Another variety of this drug comes from Barbadoes, in large gourd-shells containing upwards of half a hundredweight each; it is deep-coloured, opaque, and has a nauseous and peculiar odour, especially when breathed upon. Aloes is a warm stimulating purgative, operating as such in the dose of two to five grains. It stimulates the large intestines, and should be administered with caution in habits where there is tendency to piles, and in cases in which uterine stimulants are improper. The aqueous extract of the Barbadoes aloes is an excellent preparation, and operates mildly in grain doses.

Aloetic Acid. A resin resulting from the action of nitric acid on extract of aloes.

Aloexylon (Gr. ἀλόη, *the aloe*, and ξύλον, *wood*). The aloes wood of commerce is reputedly the produce of *A. Agallochum*, the only representative of this genus of pea-flowered plants, a tree found on the high mountains of Cochin China. This wood, also called Lign-aloes and Eagle-wood, yields a perfume which is highly esteemed by Orientals.

Aloin. The yellow neutral crystalline active principle of aloes.

Alopecia (Gr. ἀλωπεκία, *a shedding of the hair*). A morbid falling off of the hair.

Alopecurus (Gr. ἀλώπηξ, *a fox*, and οὐρά, *a tail*). A genus of grasses, called by the farmer Foxtail Grass; the flowers being arranged in compact tail-like stalks. It is very like *Phleum* or cats-tail grass, from which it differs in its glumes being acute, not truncate, and its lower pales awned. *A. pratensis* forms a part of all the richest pastures in this country.

Alosa (Lat.). The name of a genus of Clupeoid fishes, including the alose, or shad; separated from the herring and pilchard, with which it was classed by Linnæus. The shad ascends large rivers to the fresh water, where it spawns. The white-bait used to be regarded as the young of the shad, but is now ascertained to be a distinct species of the present genus.

Alphabet (from the Gr. ἄλφα, βῆτα, the two first letters of the Greek alphabet). The letters of a written language disposed in their regular order. An alphabetical language is one possessing an alphabet.

1. The first and most obvious mode by which thought can be expressed and conveyed to the eye, is by the representation of actual objects. Hence the species of writing which the learned have termed *ideographic*, i. e. in which knowledge is conveyed, first, by representations of the objects of thought; secondly, by symbols. The origin of designing is coeval with that of mankind; and men early availed themselves of this art to make their thoughts visible. To make it understood, for example, that one man had killed another, they drew the figure of a dead man stretched on the ground, and of another standing by him upright, with some deadly weapon in his hand. To let it be known that some one had arrived by sea, they drew the figure of a man disembarking from a ship; and so on. This kind of writing, if we may so employ the word, was very early used in Egypt, and probably, also, in most of the ancient nations. In Greek, the word γράφειν signifies indifferently either to write or to paint. In Mexico, when the Spaniards landed, the inhabitants of the sea-coast conveyed intelligence of the event to Montezuma by sending him a large cloth, on which they carefully painted what they had seen. It is unnecessary to insist on the difficulty and inconvenience of this method of writing; and to lessen these, recourse would naturally be had to the *symbolic* or *emblematic* variety of ideographic writing. In this method abbreviations or characteristic parts were introduced instead of the entire object. Thus, the ancient Egyptians are said to have represented a siege by a scaling ladder; a battle, by two hands holding a buckler and a bow, &c. Abstract ideas were, also, represented by symbols, or sensible objects, supposed to have a certain analogy to them: as, ingratitude by a

viper, providence by an eye, the head of a hawk, &c. 2. From ideographic was derived syllabic writing. It must have been early remarked that the sounds formed by the voice in speaking are articulate and well-defined: and the idea occurred of endeavouring to represent such sounds by appropriate signs. Thus the word *republic*, in the writing of which we use eight letters, would be written with three syllabic characters. The president De Goguet suspects that originally all the Asiatic nations, known to the ancients under the names of Syrians and Assyrians, used the syllabic mode of writing. We may, he thinks, discern the vestiges of this in an ancient tradition which ascribes the invention of writing to the Syrians; but acknowledges that the Phœnicians improved, made it more simple, and brought the characters to perfection. But this mode of writing, though a great improvement on what is purely ideographic, is still very imperfect and cumbersome. The vast number of characters required in it overburdens the memory, and occasions the greatest confusion. The existing language of the Chinese, which is partly ideographic and partly syllabic, is an example of this. In it there are a certain number of *elementary signs* or *keys* (two hundred and fourteen), which are strictly hieroglyphic or symbolical; that is, they are abridged representations of visible objects. From these 214 elements, all the characters of the language (80,000, it is said) are formed by varying and combining their figures; every compound character representing one or more syllables having a distinct meaning. 3. The defects incident to ideographic and syllabic writing being thus obvious, ingenious individuals would early endeavour to find out some more simple and precise method of communicating their ideas. And at length the method of Alphabetic writing, the greatest of all the inventions made by man, and which has been the most powerful instrument of his civilisation, would be introduced and perfected. In this method syllables are decomposed into their elements; and the few simple sounds emitted by the voice being represented each by its appropriate mark or letter, syllables and words are formed by their combination; the latter serving not only to describe external objects, but to depict the workings of the mind, and every shade and variety of thought. Before entering into the much disputed question respecting the origin of this mode of writing, it is necessary to indicate the light thrown upon the subject by the discoveries of Dr. Young and of M. Champollion, as to the phonetic writing of the Egyptians. We have already seen that the hieroglyphical characters of that people denoted, in the first place, *objects* either of sense or thought; i. e. they were ideographic. But, according to the new theory, they came in the course of time to denote sounds; and those not syllabic merely, but alphabetical. For example, the Egyptian word Ahom signified an eagle; the figure of an eagle, therefore, stood, it is said, for the letter A, with which that word begins. B was represented by a censer (Berbe). R sometimes by a mouth (Ro), sometimes by a tear (Rimé). According to the views of these discoverers and their followers, a great proportion of the inscriptions on Egyptian monuments and papyri are partly ideographic, partly alphabetical; i. e. some characters represent objects or ideas; and these are intermingled with others which merely stand for letters. Dr. Young, who first conceived the notion of the phonetic alphabet, imagined that it was only employed when foreign words or names (as those of Greek kings) were introduced. M. Champollion carried the discovery further, and applied it to the deciphering of words and names in the language of the country. The name of the ancient king Sabaco, among others, being found by this mode of interpretation, would appear to show that the phonetic writing was used as early as 700 years B.C. (See Dr. Young's writings, especially the article 'Egypt' in the Appendix to the *Encyclopædia Britannica*; those of Champollion; M. Klaproth's *Examen Critique des Travaux de Champollion*; *Quarterly Review*, vol. liii. p. 110; Salt's *Essay on the Phonetic System of Hieroglyphics*, 8vo. London, 1825, &c.

The space at our command will not allow us to enter into any detailed examination of the methods which have been applied in the interpretation of Egyptian and Assyrian inscriptions; and it would probably be rash to pronounce any definite judgement on a question in which enthusiasm on the one side is balanced by a scepticism perhaps too rigorous on the other. If the system of Champollion and his followers be right, it would be hard to place too great a value on the results which may be derived from Egyptian hieroglyphic inscriptions; but it must be remembered that in a great degree the interpretation of the Egyptian hieratic and the Assyrian cuneiform characters must stand or fall together, inasmuch as the method of Sir H. Rawlinson, Dr. Hincks, and others, is based on that of the interpreters of hieroglyphics. At the present time, the case appears to stand thus. A large number of hieroglyphic inscriptions and papyri have been either wholly or in part deciphered; and translators, unknown to each other, have given substantially the same interpretations of the same text. This agreement is especially manifest in the versions which Mr. Goodwin and M. Chabus have recently given of some very ancient papyri, lithographed in the great Prussian work, *Denkmäler Aegyptens*. One of these papyri relates the adventures of a certain Saneha, or Sineh, who rose to power under king Amenemha of the twelfth dynasty. The narrative is almost entirely personal, and throws little light on the previous history of the country. On the other hand, the scepticism avowed in the *Encyclopædia Britannica* (8th edition, art. 'Alphabet') has more recently been taken up by the late Sir G. C. Lewis, who urges the following arguments as reasons for doubting the accuracy of the methods hitherto employed in such interpretations. Apart from the inscrip-

tions of the country, the history of ancient Egypt has come down to us in the pages of four writers, who all profess to have derived their knowledge from the same source, but whose accounts are utterly irreconcileable except as regards the period succeeding to the dodecarchy, a time which closely approaches to the era of contemporary history. If we confine ourselves simply to these accounts, the principles of criticism would require us to reject them all. Here, however, comes in the alleged discovery of Champollion, with the results attained by later Egyptologists. But this discovery relates confessedly to a dead language, for the modern Coptic first made its appearance in the third century of our era. The power of deciphering the old inscriptions might also determine the affinity of the old Egyptian to the Coptic; but it was useless to apply the analogy of cipher-writing, because a cipher 'is a contrivance for disguising the alphabetical writing of a known language by a conventional change of characters' (Sir G. C. Lewis, *On the Astronomy of the Ancients*, p. 379.) The Rosetta stone appeared at this juncture to supply a hieratic record with its translation affixed; and thus the proper names occurring in the Latin version were, it was thought, identified with certain cartouches in the hieroglyphic inscription. The occurrence of the name Cleopatra on an obelisk at Philæ supplied further the signs for *l*, *o*, *p*, *a*, *t*, and it was discovered that in the hieroglyphic, hieratic, and enchorial writing alike, symbolical and alphabetical characters were intermingled, and that there were *homophone* signs, or different figures representing one and the same sound. This latter hypothesis was rendered necessary by the fact that the language had only fifteen sounds, while the signs discovered amounted to two hundred. Baron Bunsen made the further discovery that by far the greater part of the characters in Champollion's alphabet were not purely phonetic, i. e. not capable of universal application. The existence of the rest Bunsen explained by the necessity 'of employing sometimes a horizontal, sometimes a perpendicular sign, sometimes a long, sometimes a broad figure, in order to give an artistic shape and finish to each group of words.' (*Egypt's Place in Universal History*, vol. i. p. 333.) In deciphering these hieroglyphics, Egyptologists seem inclined to reject the aid furnished by the analogy of Coptic; but a further difficulty is presented in the meanings attached to the five or six hundred words that make up the Egyptian lexicon, and thus the discovery of more words seems likely only to increase the perplexity. Different signs may stand for the same sound, and the same sound may signify an indefinite number of objects. Sir G. C. Lewis further urges that, although there are one hundred and sixty-four determinatives, yet inasmuch as a 'club' is determinative of 'names of foreigners,' 'to create,' 'wicked,' and 'an eye,' the limitation would not greatly define the reader's pathway; and this difficulty is heightened when we are told that, for example, the word *ka* may mean 'a cow,' 'to begin,' 'to go before,' 'a husband,' 'a duck,' 'a substance,' 'O hail,' 'a day,' 'to set up,' 'duration,' 'an elegant kind of boat,' 'field clay,' 'to rejoice,' 'the head,' 'a limb,' 'self,' 'also.' Still further, it is asserted that this writing was not confined to the priests, but was common to all educated classes; and that this system 'of so much intricacy, consisting of ideographic, syllabic, phonetic, and determinative symbols, with a large class of homophones, or alternative signs for the same sounds, should have remained in common use by a whole nation for twenty-two centuries without alteration,' is, in the opinion of Sir G. C. Lewis, altogether incredible. But the Greeks and Romans either did not believe that these inscriptions were historical, or, if they did, made not the least effort to preserve them, while the accounts left to us of the Egyptian system of writing differ altogether from the explanations given by modern Egyptologists. Thus, Clement of Alexandria speaks of three characters, the epistolographic, the hieratic, and hieroglyphic; but as Clement's text does not in all respects suit his theory, Bunsen applies to it a more free interpretation, and remarks that 'Clement might have expressed himself better and more clearly, but it is sufficient to establish any sense for words which can otherwise have no sense at all.' It is obvious that these arguments, and the answers which may be returned to them, cannot be affected by the historical value of the narratives so brought to light. The inscriptions deciphered may be a barren enumeration of dynasties and kings; they may be the mere expression of royal presumption and popular flattery; and they may also be utterly destitute of a chronology. But the interpretation of the enigmatical characters in which they are recorded, and the grammatical system which has grown up from the discovery of the hieroglyphic alphabet, must stand or fall on its own merits. (*Encyclopædia Britannica*, arts. 'Alphabet,' 'Hieroglyphics;' *Edinburgh Review*, July 1862, art. 'Astronomy of the Ancients.')

The belief was all but universal among the Greeks and Romans, that the Phœnicians were the inventors of letters, and that the knowledge of it was brought by Cadmus, from Phœnicia, into Greece, about 1500 years B.C. From the Phœnician, therefore, or the Hebrew with which it is closely allied, are incontestably derived:—1. The Oriental alphabets used in Asia west of the Indus, written, like Hebrew, from right to left; the principal being the Syriac, Arabic, and Persian. 2. The Pelasgic, or original Greek alphabet, originally written, like the Phœnician and other eastern languages, from right to left. It was afterwards written consecutively from right to left, and left to right, in the manner that land is ploughed. This procured for it the name of *βουστρόφηδον*, or furrowed writing. This species of writing maintained its ground for a lengthened period. The laws of Solon, promulgated about 594 years B.C., were written in it; and it was used

ARABIC.

Final.		Medial.	Initial.	
ا	ـا	ـا	ا	Elif.
ب	ـب	ـبـ	بـ	Be.
ج	ـج	ـجـ	جـ	Jim.
د	ـد	ـد	د	Dal.
ذ	ـذ	ـذ	ذ	Dsal.
ه	ـه	ـهـ	هـ	He.
و	ـو	ـو	و	Wau.
ز	ـز	ـز	ز	Ze.
ح	ـح	ـحـ	حـ	Ha.
خ	ـخ	ـخـ	خـ	Kha.
ط	ـط	ـطـ	طـ	Ta.
ظ	ـظ	ـظـ	ظـ	Tza.
ي	ـي	ـيـ	يـ	Ye.
ك	ـك	ـكـ	كـ	Kef.
ل	ـل	ـلـ	لـ	Lam.
م	ـم	ـمـ	مـ	Mim.
ن	ـن	ـنـ	نـ	Num.
ع	ـع	ـعـ	عـ	Ain.
غ	ـغ	ـغـ	غـ	Gain.
ف	ـف	ـفـ	فـ	Fe.
ص	ـص	ـصـ	صـ	Tsad.
ض	ـض	ـضـ	ضـ	Dhad.
ق	ـق	ـقـ	قـ	Kaf.
ر	ـر	ـر	ر	Re.
س	ـس	ـسـ	سـ	Sin.
ش	ـش	ـشـ	شـ	Shin.
ت	ـت	ـتـ	تـ	Te.
ث	ـث	ـثـ	ثـ	The.

SANSCRIT.

Vowels.

अ	a short.	ऊ	u long.
आ	a long.	ऋ	ri short.
इ	i short.	ॠ	ri long.
ई	i long.	ऌ	lri short.
उ	u short.	ॡ	lri long.

Compound Vowels.

ए	e short.	ओ	o short.
ऐ	ai.	औ	au.

Consonants.

क	ka.	झ	jha.
ख	kha.	ड	da.
च	cha.	ढ	dha.
छ	ch'ha.	द	da.
ट	ta.	ध	dha.
ठ	tha.	ब	ba.
त	ta.	भ	bha.
थ	tha.	ल	la.
प	pa.	व	va.
फ	pna.	स	sa.
य	ya.	ह	ha.
र	ra.	क्ष	ksha.
श	sa.	ङ	nga.
ष	sha.	ञ	nya.
ग	ga.	ण	na.
घ	gha.	न	na.
ज	ja.	म	ma.

GERMAN.

Characters.	Significations.	Name.
𝔄 𝔞	A a	Au.
𝔅 𝔟	B b	Bey.
ℭ 𝔠	C c	Tsey.
𝔇 𝔡	D d	Dey.
𝔈 𝔢	E e	Ey.
𝔉 𝔣; 𝔣𝔣	F f; ff	Ef; Ef-ef.
𝔊 𝔤	G g	Gey, or Gay.
ℌ 𝔥; 𝔠𝔥	H h; ch	Hau; Tsey-hau.
ℑ 𝔦	I i	E.
𝔍 𝔧	J j	Yot.
𝔎 𝔨; 𝔠𝔨	K k; ck	Kau; Tsey-Kau.
𝔏 𝔩	L l	El.
𝔐 𝔪	M m	Em.
𝔑 𝔫	N n	En.
𝔒 𝔬	O o	O.
𝔓 𝔭	P p	Pey.
𝔔 𝔮	Q q	Koo.
ℜ 𝔯	R r	Err.
𝔖 ſ 𝔰; ſſ	S ſ s; ff	Ess; Ess-ess.
ß; ſt	sz; st	Ess-tset, Ess-tey.
𝔗 𝔱	T t	Tey.
𝔘 𝔲	U u	Oo.
𝔙 𝔳	V v	Fou.
𝔚 𝔴	W w	Vey.
𝔛 𝔵	X x	Iks.
𝔜 𝔶	Y y	Ypsilon.
ℨ 𝔷; 𝔱𝔷	Z z; tz	Tset; Tey-tset.
𝔞̊ 𝔬̊ 𝔲̊ or 𝔞̈ 𝔬̈ 𝔲̈	ae oe ue	

HEBREW AND CHALDEE.

א	Aleph.	מ ם	Mem.
ב	Beth.	נ ן	Nun.
ג	Gimel.	ס	Samech.
ד	Daleth.	ע	Ain.
ה	He.	פ ף	Phe.
ו	Vau.	צ ץ	Tsaddi.
ז	Zain.	ק	Koph.
ח	Cheth.	ר	Resch.
ט	Teth.	שׂ	Sin.
י	Yod.	שׁ	Shin.
כ ך	Caph.	ת	Thau.
ל	Lamed.		

GREEK.

Α α	Alpha.	Ν ν	Nu.
Β β ϐ	Beta.	Ξ ξ	Xi.
Γ γ ϒ	Gamma.	Ο ο	Omicron.
Δ δ	Delta.	Π ϖ π	Pi.
Ε ε	Epsilon.	Ρ ρ ϱ	Rho.
Ζ ζ ζ	Zeta.	Σ σ ς	Sigma.
Η η	Eta.	Τ τ ⁊	Tau.
Θ ϑ θ	Theta.	Υ υ	Upsilon.
Ι ι	Iota.	Φ φ	Phi.
Κ κ	Kappa.	Χ χ	Chi.
Λ λ	Lambda.	Ψ ψ	Psi.
Μ μ	Mu.	Ω ω	Omega.

SAXON.

A	a	P	p
B	b	Q	q
C	c	R	ꞃ
D	ꝺ	S	ꞅ
E	e	T	ꞇ
F	ꝼ	U	u
G	ᵹ	W	ƿ
H	h	X	x
I	ı	Y	ẏ
K	k	Z	z
L	l		⁊ and.
M	m		ð th.
N	n		ꝥ that.
O	o		

till the fifth century B.C. But writing from left to right was introduced for a considerable period before the alternate or furrowed method was abandoned. Inscriptions dated 742 years B.C. have been found written from left to right, or in the way now practised (Goguet, *Origin of Laws*, Eng. trans. ii. p. 32, &c.) From the Pelasgic alphabet were derived the Etruscan and Oscan. From the Ionic, a later variety of the Greek, came the Arcadian, the Coptic, and Ethiopic, the Mœso-Gothic and Runic, and, in comparatively modern times, the Armenian, Illyrian, Sclavonic, Bulgarian, and Russian. With regard to Greek writing, it is to be observed that the most ancient mode was in capitals. The small letters now in use seem to have been introduced gradually; for, in our oldest Greek MSS., even as early as the fifth century, they appear intermixed with capitals. But the latter were principally employed until the seventh or eighth century. 3. The Latin alphabet is also derived from the Ionic Greek. In the earliest inscriptions which we possess, the forms of the letters scarcely differ from those in use at the present day; but great varieties have been in subsequent times introduced: first, in the ordinary method of writing it; as, the Uncial, Semi-Uncial, Lombard, Italic, &c. [CHARACTER.] Secondly, in the number and form of the letters contained in the numerous alphabets derived from it. 4. A fourth class of alphabetical languages consists of the Sanscrit and its derivatives. These are very numerous, and are spoken in the continent and islands of India. The antiquity of the Sanscrit alphabet is undoubtedly great; but those who assign to it a separate origin are probably in error. Indeed, the great regularity of the Devanagaree, or most elegant form of the Sanscrit alphabet, and its copiousness (it contains 100 letters), seem to afford strong presumption that it was compiled by some learned individual, or body (like the Russian and other modern Western alphabets), from other forms of writing then in use, and imported into India from the West. The Sanscrit and its derivative languages are written, like European, from left to right. These four classes comprehend all the alphabetical languages in existence. The following table exhibits the number of letters in some of the principal:—

Class 1. Hebrew, Samaritan, Syriac, and Chaldean, 22 each. Phœnician (known), 17. Arabic, 28. Persian, 32.

Class 2. Greek, 24. Armenian, 38. Ethiopic, or Abyssinian, 202. Modern Russian, 41.

Class 3. (which is only a subdivision of Class 2.) Latin, 22. English, 26. French, 28. Italian, 20. German, 26.

Class 4. Sanscrit (Devanagaree), 100.

Various learned persons have proposed the adoption of a universal alphabet; and have shown that the elementary sounds are reducible to a smaller number than those employed in our Western alphabets. Harris (*Hermes*, book iii. c. 2) estimates them at twenty, Wachter (*Naturæ et Scripturæ Concordia*) reduces them to ten. Bishop Wilkins, in his *Essay towards a real Character and Philosophical Language*, estimates them at thirty-four.

The table given in the preceding page contains specimens of the principal alphabets. For cuneiform inscriptions see CUNEIFORM LETTERS.

Alphonsin. An instrument for extracting balls: so called from the name of its inventor, Alphonso Ferri, a Neapolitan surgeon.

Alphonsine Tables. Astronomical tables, constructed and published in 1252 by Isaac Hazan, a learned Jewish rabbi, under the patronage of Alphonsus X., King of Aragon.

Alpine Plants. Low plants which grow naturally in hilly or mountainous situations, where they are covered with snow during great part of the winter; for which reason, in gardens, they require the protection of frames and glass at that season. In this respect Alpine plants differ from rock plants; which, in gardens, only require to be grown among rocks or stones, without the protection of a frame and glass.

Alpiniaceæ. One of the names of the natural order of plants called *Zingiberaceæ*.

Alps. This great and important mountain chain may be regarded as a central and culminating portion of the western division of the elevation-axis of the Old World. The eastern division culminates in the Himalayan chain, and numerous spurs and parallel but shorter chains are formed by the Albanian mountains, extending into Greece, the Apennines, and the high lands of Corsica and Sardinia. The Pyrenees form a western continuation, separated by the valley of the Rhone and the Gulf of Lyons; the Carpathians, an eastern link, separated by the valley of the Danube. The Atlas chain of North Africa, and the Sierra Nevada of the south of Spain, are portions of parallel chains, the former separated by the Mediterranean, and the latter connected by the table-land of Spain.

The Alps thus limited rise from the Gulf of Genoa, and soon attain their greatest elevation in Mont Blanc (15,810 feet). At and near this point they form important knots, in which are Monte Rosa, the Jung Frau, and many other well-known mountains, separated by deep valleys. These mountains are for the most part pinnacles or pyramids of porphyritic rock rising out of fields of ice and snow perpetually renewed and yielding the principal glaciers of the chain. These knots are about sixty miles in extreme length. From them the mountains continue towards the east, through the Grisons and Tyrol, and become gradually lower as they approach the valley of the Danube, terminating with the table-land of Carinthia and the hills of western Hungary on the right bank of the Danube. Besides the central knots and ridges of the Alps, there are many parallel and flanking chains and groups and innumerable secondary branches. The mountain knots already referred to include the group of the Bernese Alps. The Jura mountains flank these Bernese Alps, and the valley and lakes of Switzerland lie between. The eastern exten-

sion of the Alps beyond the Great Glockner splits into two branches, the Noric and Carnic Alps, the latter being the continuation of the main chain. It passes into the Julian Alps, and so is connected with the mountains of the Balkan. The higher part of the Alpine chain is about a hundred miles from north to south; eastward the width increases to two hundred miles, and then diminishes to eighty miles at the Balkan.

There are many practicable passes across the Alps, but all are high. The Stelvio is the highest, and is 9174 feet above the sea. The St. Bernard is the highest that has a regularly inhabited house at the summit. The Simplon is the most frequented of those that pass from North to South. The Mont Cenis connects Italy with France. The St. Gothard and Splugen pass cross the crest of the chain, but the others ascend by some valley, and crossing the water-shed avoid the extreme heights. The Alps properly so called have no table-lands directly connected with them. Several of the principal rivers of Europe take their rise from Alpine valleys. The Rhine, the Rhone, and the Danube are the largest.

Alrunæ (Germ. Alraune, Alraun-bilder). Small images carved out of the roots of trees, exhibiting rude representations of the human figure, generally female. Regarded by the northern nations as the Penates, or household gods, of families, they were laid in boxes, and presented with meat and drink. They are supposed by some to represent female magicians.

Alsegno (Ital. *to the mark*). In Music, a notice to the performer that he must recommence from that part of the movement to which the sign or mark 𝄋 is prefixed.

Alsineæ. A rather extensive group of the order *Caryophyllaceæ* of weedy plants, allied to the much more beautiful *Silenaceæ*, from which they are known by their calyx consisting of distinct sepals. The group derives its name from *Alsine*, the common Chickweed.

Al-sirat (Arab. *the path*). In Mohammedan Theology, the name of a bridge extending over the abyss of hell, which must be passed by everyone before entering heaven. It is described as being as narrow as the edge of a sword.

Alstonite. A carbonate of baryta and lime, of a white or grey colour, occurring in veins with Galena, at Brownley Hill, near Alston, in Cumberland; and in small six-sided pyramidal crystals, of a pinkish tinge, at Fallowfield in Northumberland.

Alstonite has the same composition as Barytocalcite, but differs from it by crystallizing in oblique prisms, instead of in right rhombic prisms.

Alt (Lat. altus, *high*). In Music, a term applied to the high notes of the scale.

Altaite. A telluride of lead, occurring crystallized in cubes, but generally in tin-white granular aggregates, with a yellow tarnish, at the Savodinsky Mine in the Altai, mixed with telluric silver.

Altar (Lat. altare). In Architecture, the name given to a consecrated table, generally raised above the ground, on which sacrifice was offered.

In the countries of classical antiquity, there seems to have existed some doubt as to what constituted the difference between the *altare* and the *ara*, and with respect to the meaning of the altar itself. Thus it is supposed that there were three kinds of altars—one for sacrifice externally; one for incense and libations at the foot of the image of the deity; and the third for offerings, which was portable. It is held by some critics that the *altare* was devoted to the *dii majores*, or *cœlestes;* the *ara*, or *craticula*, to the *dii terrestres;* and the *focus*, *scrobiculus*, or trench, to the *dii infernales:* otherwise *altare* is regarded as the altar for sacrifice, and *ara* as that for prayer. The distinction drawn by Servius and Pollux between the *altare* and the *ara* must not be overlooked, though it would appear that the distinction between the two was a mere arbitrary one, and that the words were used indefinitely by the ancients. The earliest form adopted was that of square polished stones, on which were placed the offerings to the gods. Whilst sacrifices were confined to libations, perfumes, and offerings of that kind, the altars were small, and even portable; but as soon as men thought they were doing an honour to the Deity by an offering of blood, they began also to increase the dimensions of their altars. Different forms were contrived, according to the nature of the sacrifice, and according to the nature of the worship offered; as, for instance, the altar of the Villa Pamphili at Rome, upon which are to be seen the cavity for holding the fire and the grooves for holding the blood. Many of the monuments of this description were erected merely as testimonies of the piety of those who built them, whilst others were constructed to commemorate some great event: they served for adjuration, as well as for an asylum for the unfortunate, and for the evil-doer. Their forms varied from square to oblong, from triangular to circular. Those of metal were tripodial; those of brick or stone were usually square on plan; and occasionally, according to Pausanias, they were composed of wood. They do not seem to have been of any definite height, inasmuch as they are sometimes seen in bassirilievi, reaching a little above a man's knee, whilst in others they reach about his middle; though it would seem that the circular altar was the higher in proportion to its diameter. Vitruvius says that they should be kept down in height, so as not to interfere with the statues of the gods, and he proceeds to lay down the heights they should bear. Thus, he states that the altars of Jupiter, and the celestial gods, ought to be the loftiest; next, those of Vesta and the terrestrial gods; then the sea gods were to have theirs a little lower; and so forth. On the festivals of the gods to whom the altars were dedicated, they were decorated with such flowers and leaves as were sacred to the par-

ticular divinity; but, in addition to this casual decoration, the ancient altars furnish us with some of the most elegant bassi-rilievi and foliage ornaments that are extant. According to Vitruvius, their fronts were turned towards the east, though often little regard seems to have been paid to their position, as they were occasionally deposited under the peristyle of a temple, and not unfrequently in the open air, or in the public place of a town.

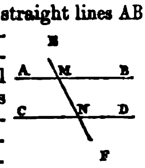
The word *Altar* was adopted by the early Christians, together with the corresponding Greek term θυσιαστήριον, (but not, unless, perhaps, in a single instance, βωμός,) to express the table of the Lord (1 Cor. x. 21.). But the word altar is stated to have been used by the fathers in four different senses (v. Suicer, in voc. θυσιαστήριον): for, 1. Christ himself, from Hebr. xiii. 10. 2. The church of Christ in general. 3. Individual members of the church. 4. The Lord's table. It is observed that the fathers of the first three centuries universally speak of the altar, and not of the table, although constantly admitting the charge which the heathens made against them of their having no altars, conceiving the term as used by the heathens to imply the offering of a sacrifice upon the altar, and the presence of the statue of the deity to whom the offering is made. From the fourth century the word table is frequently adopted, as by St. Chrysostom, St. Augustin, &c.

In King Edward's Book of Common Prayer the word 'altar' was retained in the communion service, but great objection being taken to it, especially by Bishop Hooper, on account of the ambiguity of its meaning, and of the apparent sanction it might appear to lend to the Romish doctrines of the Eucharist, it was abandoned, and the word 'table' was substituted for it throughout. This did not, however, satisfy the more violent party, and, on the restoration of the reformed worship, on the accession of Elizabeth, the people proceeded to take the first step towards a real and verbal substitution by pulling down the altars in many churches. Thereupon the queen issued an injunction, wherein she declared that 'it is no matter of great moment whether there be altars or tables, so that the sacrament be duly and reverently administered; and directs that where the altars have been pulled down, tables should be erected in their place.'

Alteratives (Lat. altero, *I change*). Medicines which cure diseases by slow and imperceptible degrees, without producing sensible evacuations.

Alternate (Lat. alternatus). In Botany, parts are said to be alternate with each other when one is placed upon the stem a little higher or a little lower than the other; the word is chiefly applied to leaves, and is used in distinction to opposite, in which parts arise from the same plane on opposite sides of the stem.

Alternate Angles. When two straight lines are intersected by a third, the interior angles on the opposite sides of the intersecting line are said to be alternate. Thus AMN and MND are alternate angles; and so also are BMN and MNC. If the two straight lines AB and CD be parallel, the alternate angles are equal. Sometimes, especially by continental mathematicians, the angles AMN and MND are called alternate *internal* angles, to distinguish them from such angles as AME and FND, which are called alternate *external* angles.



Alternate Generation. In Biology, that modification of generation in which the young do not resemble the parent, but the grand-parent; so that the successive series of individuals seem to represent two species alternately reproduced. The *salpa*, a floating gelatinous molluscous animal, is an example: it may be found as a solitary individual, pregnant with numerous minute salpæ, of a more simple structure, which continue after birth to be united together in the form of a long chain floating on the sea. In each individual of this chain there is generally developed an egg, from which is hatched a solitary salpa, of the form and organisation of the parent of the chain of aggregate salpæ: thus the species is represented by an alternation of simple and aggregate salpæ. [PARTHENOGENESIS.]

Alternately or **by Alternation.** In Proportion, a phrase indicating the transposition of the second and third terms. Thus, Euclid proves (v. 16), that if the first of four like magnitudes be to the second as the third is to the fourth, then *alternately* the first is to the third as the second to the fourth.

Alternation. A term formerly used for what is now called *permutation*. [PERMUTATION.]

Althæa (Gr. ἀλθαία, from ἄλθω, *to make sound*). The most important species of this family of *Malvaceæ* are the Hollyhock, *A. rosea*, a well-known garden flower, and the Marshmallow, *A. officinalis*, the latter of which is a common plant in marshes near the sea, and is used, especially in France, under the name of Guimauve, to form demulcent drinks.

Althein. A white crystalline matter contained in althea root. It is identical with asparagin.

Althionic Acid. An acid isomeric with sulphovinic acid, and probably a compound of that acid with isethionic acid.

Altica. A name applied by Fabricius to a subdivision of the Linnæan *Chrysomelæ*, characterised by the oblong body, bifid lip, and thickened hind legs.

Altimetry (Lat. altus, *high*, and Gr. μετρέω, *I measure*). The art of measuring heights by means of instruments. It is founded on the principle that the corresponding sides of triangles having equal angles are in exact proportion to one another.

Altitude (Lat. altitudo). In Astronomy, denotes the angle of elevation of a celestial object, or the angle of the visual ray with the

horizon. The altitude of a star is apparent or true. The apparent altitude is the angle ascertained immediately from observation; the true altitude is found by correcting the apparent altitude for refraction, parallax, &c. Altitude is frequently used in Elementary Geometry instead of height. The altitude of a triangle is measured by a perpendicular let fall from the vertex to the base; and the altitude of a cone by the straight line drawn from the vertex perpendicular to the plane of the base.

Alto (Ital.). In Music, the counter-tenor part of vocal compositions, or that immediately below the treble or highest. It is a word also used to denote the tenor violin.

Alto Rilievo. [RILIEVO.]

Aludel. A piece of chemical apparatus used in the process of sublimation, and much resembling the ancient alembic.

Alula. In Ornithology, the group of feathers, attached to the joint of the carpus; as in the snipe. These are also called the 'bastard wings' (*ala spuria*).

Alum (Lat. alumen). A salt composed of alumina, potash, and sulphuric acid, and in its usual form containing a large quantity of water of crystallisation. Its octohedral crystals consist of

Alumina	3 atoms	=	54	10·76
Potassa	1	=	48	9·95
Sulphuric acid	4	=	160	33·74
Water	24	=	216	45·55
Crystallised alum	1	=	478	100·00

Alum dissolves in about five parts of water at 60°. The solution has a sweetish astringent taste, and is a powerful styptic. When crystallized alum is heated, it melts, and, gradually losing water of crystallization, becomes a white spongy mass, called burned alum.

Alum is largely manufactured for the uses of the arts, especially dyeing and calico printing. What is termed *alum ore* is an aluminous slate containing sulphuret of iron; it is calcined, exposed to air, lixiviated, and the solution so obtained mixed with sulphate of potash, and crystallized. The alum-works near Paisley, and at Whitby, in Yorkshire, are the largest in this country.

Milk, curdled by stirring it with a lump of alum, furnishes *alum whey*, which is sometimes taken as a remedy for relaxed bowels. *Alum curd* is made by beating the white of egg with a piece of alum till it coagulates.

Alum is found *native* in translucent octahedral crystals, and also in fibrous masses, or as mealy efflorescences, on aluminous rocks and lava. The lias-shales of Whitby in Yorkshire, and the lower coal-measure shales of Hurlet and Campsie near Glasgow, until within a few years furnished the chief sources from which the alum of commerce was obtained in Britain; but recently it has been largely manufactured at Manchester, and at Goole in Yorkshire, from the carbonaceous shales of the coal measures.

Alum Shale (*Alum schist*, or *alum slate*). A deposit consisting of clay, in a state tending to split readily, combined with much iron pyrites and also with an irregular proportion of bituminous or carbonaceous matter. In England the principal alum schists are in the upper part of the lias, developed largely at Whitby in Yorkshire. In Scotland they occur in the coal measures. On the Rhine similar deposits are of tertiary age. There is no reason why they should not be found in rocks of any period. The alum of commerce is obtained by a double decomposition, induced by burning the alum schist slowly with moisture until its condition is sufficiently changed, and then adding sulphate of potash or ammonia. Little or no fuel is generally required, as the bituminous composition of the schist causes it to burn when once set on fire without further help. The slow burning sometimes commences spontaneously, owing to the heat generated by the decomposition of the pyrites when moisture gains access to it.

The alum shales of the Yorkshire coast are associated with deposits of *jet*, a peculiar carbonaceous mineral used for ornamental purposes.

Alumina. Aluminous earth; earth of alum; argil. When a solution of ammonia is added in excess to a solution of alum, a white precipitate falls, which, thoroughly washed, dried, and heated, is nearly pure alumina. There are two properties of this earth which render it of great importance in the arts: one is, that it forms a plastic mixture with water, and, though it is not the predominant ingredient in, yet it confers the valuable property of plasticity upon, all natural clays, which enables them to be moulded into the various forms of pottery and earthenware; the other is the remarkable affinity of alumina for colouring and extractive matter and for vegetable fibre, whence its use in the arts of dyeing and calico printing.

In a pure and crystalline form, alumina constitutes the *sapphire*, one of the hardest and most valuable of the gems. In its common state, aluminous earth is a soft white powder, strongly attractive of moisture; hence, aluminous fossils are often recognised by adhering to the tongue, and many of them exhale an earthy smell when breathed upon, as we observe in common slate. Alumina consists of 52·94 aluminum, and 47·06 oxygen; like the other earths, as they are usually called, alumina, therefore, is a metallic oxide.

Alumina has but a feeble attraction for acids, and does not fully neutralise them; and when it has been heated red-hot, or is in an indurated state, as it exists in the sapphire, in corundum, and some other minerals, it is absolutely insoluble.

The aluminous salts are mostly colourless, soluble in water, and of a sweetish astringent taste. Exclusive of alum, the acetate of alumina is the most important of these salts, being used as a base or mordant by the dyers. [DYEING.] It is usually prepared by mixing a solution of

190 parts of acetate of lead with one of 478 parts of alum: a white precipitate of sulphate of lead falls, and acetate of alumina remains in solution.

Aluminite. Native subsulphate of alumina. [WEBSTERITE.]

Aluminum, or **Aluminium.** The metallic base of alumina. It is obtained principally, for the purposes of commerce, from the decomposition of the chloride of aluminum by sodium. The metal is remarkable for its specific gravity, being about ¼ that of silver, the specific gravity of aluminum being 2·56, that of silver 10·47. The tenacity and elasticity of aluminum are equally remarkable. It is used largely in the preparation of alloys, and for the cheaper descriptions of jewellery. *Aluminum bronze*, which is an alloy of copper and aluminum, has a golden hue.

Alumocalcite. An impure Opal of a milk-white colour inclining to blue, and containing 6 per cent. of lime, and 2 of alumina. It is found at Eibenstock in Saxony, in veins of ironstone.

Alums. Crystalline compounds similar in crystalline shape and in constitution to common alum, which is a double sulphate of alumina and potash. An alum may contain soda or ammonia in the place of potash, and oxide of iron, of chromium, or of manganese in the place of alumina. All the alums crystallize in octohedra.

Alumstone. A native subsulphate of alumina and potash, from which much of the alum of commerce is made, after frequent roasting and lixiviation in water. It occurs massive and crystallized in modifications of an obtuse rhombohedron; the colour is generally greyish-white, sometimes reddish. The crystals, which line cavities in the massive alumstone, are minute, shining, translucent and white, sometimes brownish externally. The massive kind frequently contains a large amount of silica as an impurity, sometimes to the extent of 60 per cent. Alumstone is principally found in volcanic districts, at Tolfa near Civita Vecchia, in the Papal States, at Musay and Bereghtzasz in Hungary, Pic de Sancy in France, &c. Some of the Hungarian varieties are so hard and compact as to be used for millstones.

Alunite. A mineralogical synonym for Alumstone.

Alunogene. A hydrous sulphate of alumina resulting from volcanic action and the decomposition of pyrites in shales. It is found in various parts of North and South America, and at Adelaide in New South Wales.

Alurnus. A genus of coleopterous insects, characterised by having short filiform antennæ, palpi four to six, very short; maxillæ horny and short.

Alveolar (Lat. alveolus, diminutive of alveus, *a cavity*). Belonging to the alveoli, or sockets of the teeth.

Alveolate. In Botany, when the surface is covered with numerous deep hollows, as in the receptacle of some *Compositæ*.

Alveolites. A genus of fossil zoophytes, allied to the corallines; one species of which (*Alv. suborbicularis*) occurs in the Portland stone.

Alvine (Lat. alvus, *the belly*). A term generally used as relating to the intestinal excretions.

Alvite. A mineral composed chiefly of silica, lithia, thorina (?), alumina, glucina, peroxide of iron, and water. It is found at Helle and Narestö in Norway, in crystals like those of Zircon and of a reddish-brown colour which becomes greyish-brown by alteration.

Alyssum (Gr. ἄλυσσον). A genus of Cruciferous herbs, bearing the common name of Madwort. One species, *A. saxatile*, is popularly known as gold-dust, from the bright yellow colour of its blossoms.

Amadou. German tinder, made of a fungus (*Boletus igniarius*) found chiefly in old oaks and ash trees. It is boiled in water, dried, beaten, soaked in a solution of nitre, and again dried for use.

Amain. A sea term, signifying *to yield, to let go.* Thus, to strike amain is to lower or let fall the topsails, in token of surrender. To wave amain is to make a signal to a vessel to strike its topsails. Amain is also a term used in letting down a thing into the hold or elsewhere, or in lowering a yard, or the like, to denote that the sailors are to let go that part of the rope which they held before, and let down the thing easily and by degrees.

Amalfian Code. A collection of marine laws compiled by the Amalfians about the end of the eleventh century. It was for a long time the authority in countries washed by the Mediterranean.

Amalgam. A combination of mercury with other metals. Medallists apply the term to soft alloys generally.

Amalic Acid. A crystalline body resulting from the action of chlorine on caffeine. It is identical with dimethyl-alloxantin.

Amalthæa (Gr. ἀμάλθεια). In Mythology, the name of a nymph, or, according to others, of a goat, which is said to have suckled Zeus (or Jupiter) in Crete. The *cornu Amalthææ* was the magic *cornucopiæ*, or horn of plenty.

Amandin. The name given to the vegetable casein of sweet and bitter almonds.

Amanita (Gr. ἀμανῖται). A group of white-spored Agarics, one species of which, *A. muscaria*, the fly-mushroom, ranks amongst the most poisonous of the fungi of this country. It renders water in which it is boiled so poisonous that animals are killed by it, while the boiled fungus itself is nearly harmless. The liquid procured by it is used as a *fly-poison*, whence the name of the mushroom is derived.

Amansite. A variety of compact Felspar, from Ædelfors in Sweden. It is of a clear grey colour passing into greyish-white.

Amaranthaceæ. The order of Monochlamydeous plants which comprehends the *Amaranthus*, and other similar dry-flowered

genera. Some of the species are cultivated as objects of ornament, as Cockscombs (*Celosia cristata*), Globes (*Gomphrena globosa*), various species of *Amaranthus*, *Trichinium*, &c.; the principal part consists of tropical species. The order participates in the harmless qualities of *Chenopodiaceæ*, from which it is not very different.

Amaranthus (Gr. ἀμάραντος, from ἀ, neg., and μαραίνω, *I wither*). The name of certain herbaceous, mostly annual plants, with richly coloured flowers, whose parts are of a thin dry texture, so that they are a long while before they wither. They are types of the natural order *Amaranthaceæ*. *Amaranthus melancholicus*, *hypochondriacus*, *caudatus*, &c., are the annuals known in gardens by the names of Love lies bleeding, Prince's feather, &c. The name, in composition with other words, is used to designate plants not belonging to the same genus, but to the same natural order. Globe Amaranth is *Gomphrena globosa*.

Amarine (Lat. amarus, *bitter*). An acicularly crystalline basic substance produced by the action of ammonia on oil of bitter almonds.

Amaryllidaceæ (Amaryllis, one of its genera). A natural order of beautiful Endogens, with inferior fruit, six stamens, and six nearly equal segments of the flower. The greater part consists of bulbous species inhabiting the Cape of Good Hope and the tropical parts of both hemispheres. Snowdrops are the most northern form. A few, such as *Agave* and *Doryanthes*, are trees in stature, although only herbaceous plants in duration.

Amarythrin. A product of the oxidation of orsellic ether.

Amasatine (*Isamide*). One of the products of the action of ammonia on isatin.

Amaurosis (Gr., from ἀμαυρός, *dark*). A loss of sight dependent upon defective action of the nerve of vision, and independent of visible injury. It is also called gutta serena, the 'drop serene' of Milton.

Amazon-stone. A beautiful bluish-green kind of Felspar, found in America, in rolled masses near the river Amazon; also in Siberia, near Lake Baikal, and of a verdigris-green colour on the shores of Lake Ilmen. It is made into ornamental articles.

Amazons (usually derived from Gr. ἀ, *without*, and μάζος, *the breast*, but probably to be compared with ἀδελφός). A tribe or community of women, who are said to have lived on the plain of Themiskyra, on the banks of the Thermodon, and from that place to have made many expeditions into other countries. Their queen Penthesileia aided in the defence of Troy; another queen, Antiopê, was assaulted and defeated by Theseus. The belief in these legends produced the tradition that, on the advance of Alexander the Great into Asia, the Amazonian queen Thalestris hastened to meet him. The American river Amazons was so called by one of the early Spanish navigators, who fancied that he saw armed women on the banks. The wars of the Athenians and Amazons were depicted in the Pœcile, or painted chamber of the Parthenon. For an examination of the legends respecting the Amazons, see Grote's *History of Greece*, vol. i. ch. 11.

Ambarvalia (Lat., from ambire arva, *to go round the fields*). In Roman Antiquities, sacrifices, so called from the victims being carried round the fields (Virgil, *Georgics*, i. 345). These rites were performed by an order of priests, twelve in number, called Arvales Fratres, at the end of May, to invoke the blessing of Ceres on the coming harvest. Crowds of country people accompanied the victim, having their temples bound with oakleaves, dancing and singing the praises of the goddess, to whom libations were made of honey and wine.

Ambassador, or **Embassador.** A word of very uncertain derivation, but supposed to be derived from the Italian word ambasciare, *to solicit*). In Politics, the name of the highest order of foreign ministers. An ambassador is not only the agent of the country which sends him, but also represents personally the dignity of its sovereign. Since the Congress of Vienna, representatives have been usually divided into three classes: ambassadors, envoys, or *chargés des affaires*, the last of these communicating not between the heads, but between the foreign departments of Governments. The only ambassadors now sent by Great Britain are to France and Turkey: our other ministers abroad are termed envoys, or Ministers plenipotentiary. As to the rights and privileges of ambassadors in England, if an ambassador commit any act which is a crime against the law of all countries, he is punishable as a private alien. But an ambassador is not criminally liable for such acts as are only mala prohibita against statute or custom; as, infringements of the laws of the exchequer. By 7 Anne, c. 12, an ambassador or public minister, and his domestic servants, *bonâ fide* registered are privileged from arrest; and his goods cannot be taken in distress. This statute was passed in consequence of the arrest and ill-treatment of Count Matuschef, the Russian ambassador. As to the rights and duties of ambassadors in modern usage, see de Wicquefort, *L'Ambassadeur et ses Fonctions*, 2 tomes, 4to, 1746; and the *Manuel Diplomatique* of Von Martens.

Amber (Fr. ambre; Ital. ambra; Arab. ambas). The mineralised resin of extinct pine-trees. It is collected in large quantities on the shores of the Baltic Sea, and is also dug up in alluvial deposits of sand and clay, where it is found in rounded masses associated with fossil wood, iron pyrites, and alum shale. It often contains leaves of plants and insects, which are mostly of extinct species. It is hard and brittle, and becomes strongly electro-negative by friction. It is soluble in alcohol, and has a specific gravity of 1·08. It burns with a yellow flame and a fragrant odour, and leaves 12 or 13 per cent. of a black shining charcoal, which, when strongly heated, yields a little volatile

matter resembling camphor. Distilled *per se*, it affords inflammable gases, water holding succinic and acetic acids, and empyreumatic oil in solution (the spirit of amber, of old pharmacy), sublimed succinic acid (salt of amber), and an empyreumatic oil (oil of amber). The acid, when purified, amounts to from 3 to 5 per cent.

The chief use of Amber is for mouth-pieces of pipes, and as an article of ornament, cut into beads for bracelets and necklaces, &c. It is also used for making oil of amber and succinic acid, and forms the basis of some varnishes.

One of the largest known masses of Amber, weighing eighteen pounds, was found near the surface of the ground in Lithuania, about twelve miles from the Baltic: it is in the royal cabinet at Berlin. For the nature and course of the amber trade in the ancient world, see Sir G. C. Lewis's *Astronomy of the Ancients*, p. 458, et seq.

AMBER was also the name of an English measure of four bushels. [DOMESDAY BOOK.]

Ambergris (Fr. ambregris, *grey amber*). This substance is found in the intestines of the spermaceti whale: it is probably a product of disease; perhaps a kind of gallstone. It is also found upon the coasts of various tropical countries, in masses of various sizes, of a grey, speckled appearance, and interspersed throughout its substance with the beaks of the *Sepia octopoda*, which is the common food of the whale. When genuine, ambergris has a peculiar odour, not easily described or imitated, and which is exceedingly diffusive, especially in solution, so that a very minute quantity of ambergris is perceptible in perfumes, and is thought to exalt their odour. A grain or two when rubbed down with sugar, and added to a hogshead of claret, is very perceptible in the wine and gives it a flavour, by some considered as an improvement. The best ambergris is softish and somewhat waxy when cut; its specific gravity varies from ·780 to ·896: it fuses at 140° or 150°, and at a higher temperature gives out a white smoke, which condenses into a crystalline matter. Its chief component (about 80 per cent.) is a peculiar fatty matter (ambrein), which may be obtained by boiling it in alcohol.

Ambidexter (Lat. ambo, *both*, and dexter, *right hand*). One who uses both hands alike, the left as well as the right. Numerous theories have been advanced to explain the preference so generally given to the right over the left hand; but, generally, they seem to be more specious than solid.

Ambitus (Lat). The circumference or extreme edge of any thing; the encompassing border of a leaf.

AMBITUS. In Politics, a term used by the ancient Romans to designate the soliciting and canvassing for offices and honours. It was of two kinds, the one, *ambitus popularis*, laudable; as, where a candidate openly avowed his pretensions, publicly stated the grounds on which he solicited the suffrages of the electors, and left them to form their opinion upon his claims without privately soliciting their votes. The other, and more common kind of *ambitus*, was either disreputable or unlawful. It consisted in using artful solicitations, cajolery, offers of money and preferment, and all those resources for corrupting the free choice of electors, so well understood and so successfully practised in our own times. To secure the elector, a regular system was devised for ensuring secrecy. The bargain was made by *interpretes*, while the money was held by *sequestres*, until it was distributed to the electors by *divisores*. The bribery of electors was forbidden, although to very little purpose, by repeated acts of the Roman legislature. (Smith, *Dictionary of Greek and Roman Antiquities*; Facciolati, *Lexicon*. See also the article CANDIDATE.)

Amblotis (Gr. ἀμβλωσις, *abortion*). The generic name, in the system of Illiger, of the Marsupial genus including the wombat.

Amblygon (Gr. ἀμβλύς, *obtuse*, and γωνία, *an angle*). In Geometry, an obtuse-angled triangle.

Amblygonite. A phosphate of Alumina and Lithia, in combination with double fluoride of aluminum and lithium, occurring massive and in oblique rhombic prisms, which are rough externally, and of various tints of pale green, near Penig in Saxony, in coarse granite; and at Arendal in Norway.

Amblyopia (Gr. ἀμβλυωπία, from ἀμβλύς, *dull*, and ὤψ, *the eye*). Imperfect vision.

Amblypterus (Gr. ἀμβλύς, *obtuse*, and πτερόν, *a fin*). The name of a fossil genus of Lepidoganoid fishes, with obtuse and rounded pectoral and ventral fins, and characterised by having small and numerous teeth, set close together like a brush, which shows the habit of these fishes to have been to feed on decayed seaweed and soft animal substances at the bottom of the water.

Ambo (Gr. ἄμβων; Lat. ambo). A raised platform, from which in the primitive church the epistle and gospel were read to the people. It was also used sometimes for preaching, and was most commonly placed on the north side of the entrance into the choir or chancel. As the ambo was ascended by steps, the office performed there was called the Gradual. The ambos were sometimes moveable; two specimens of this kind may still be seen in the church of St. John Lateran at Rome.

Ambreic Acid. An acid formed by the action of nitric acid on ambrein.

Ambrein. A fat-like crystalline substance found in ambergris. It somewhat resembles cholesterin.

Ambrosia (Gr. *immortal*). The food of the gods (as nectar was their drink), withheld from mortals as containing the principle of immortality.

Ambrosian Chant. In Music, (so called from St. Ambrose, archbishop of Milan, who composed it for the church there in the fourth

century): a chant distinguished from the Gregorian by less variety in its melody.

Ambrosian Office. In Ecclesiastical History, (so called from St. Ambrose, Bishop of Milan,) the ritual preserved in the diocese of Milan, in many points of minor importance differing from that of Rome.

Ambry or **Aumbry.** In Ecclesiastical Architecture, a place where charters, &c., and sometimes the sacred vessels, were deposited. Also an office in which charitable contributions for the poor were laid up for safety. In the latter sense the word is confused with *almonry*; in the former it must be traced to the Fr. armoire. Lat. armarium, a cupboard. (Wedgwood, *Dictionary of English Etymologies.*)

Ambubaiae. A Syrian or Arabic term, meaning musical girls from Syria, who obtained their livelihood by performing in public at Rome.—See Hor. *Sat.* lib. i. sat. 2, v. 1, and *Juvenal*, iii. 65.

Ambulacra (Lat. ambulacrum, *an alley*). The narrow longitudinal portions of the shell of the sea-urchin (*Echinus*), which are perforated with a number of small orifices, giving passage to tentacular suckers, and alternate with the broad tuberculate spine-bearing portions.

Ambulatores (Lat. from ambulo, *I walk*). The name of an order of birds in the system of Illiger, corresponding nearly with the *Passeres* of Linnæus.

Ambulatory. Formed for walking. In Ornithology, the term is applied to the feet of birds where the toes are placed three before and one behind.

Ambulatory. In Architecture, a place to walk in, whether wholly or partially covered. The position of an ambulatory may be either external to the building it was intended to ornament, as in the peripteral temple; or internal, as in a cloister. The peculiar arrangement known as the Rows at Chester constitutes a description of ambulatory, of which there are good specimens in the streets of some continental cities, such as Genoa, Bologna, Naples, &c.

Ambulatory. In Law, a court which moves from place to place, as in England, the King's Bench, when in old times it accompanied the person of the sovereign.

Ambuscade. A military term derived from the Italian *imboscata*, concealed in a wood. It is also applied to any snare laid for an enemy.

Ambustion (Lat. ambustio). A medical term for a burn or scald.

Amen (Heb. אמן, signifying, *let it be*, or rather, *let it be irrevocably fixed*). It is understood to express belief and assent at the end of a prayer. It is sometimes translated *verily*, as when used at the beginning of a discourse.

Amende Honorable. In French Law, a species of infamous punishment, to which criminals guilty of an offence against public decency or morality were condemned under the ancient system, and are so still in some instances. Such were, sedition, forgery, sacrilege, fraudulent bankruptcy, &c. The *simple* or *dry* amende honorable consisted merely of an acknowledgement by the criminal of his offence in open court, bare-headed and kneeling. The *amende honorable in figuris* was made by an offender, kneeling in his shirt, a torch in the hand, a rope round the neck, and conducted by the executioner. It was, and still is, usually conjoined with some other punishment; sometimes capital, as in the case of parricides, &c.

Amendment. In a general sense, is any change made in any thing for the better. In Parliamentary Proceedings, it is an alteration in the words of any bill or motion, which it is competent for any member to move when the bill or motion has been read. [Parliament.]

Amendment. In Law, the correction of an error committed in any process, as the amendment of a declaration, plea, &c. The deficiency of means of amendment in pleading at common law led to the statutes of amendments and jeofails, beginning with that of 14 E. 3. All amendments are held to be within the discretion of the court, and allowed in furtherance of justice according to the particular circumstances of each case.

Amenorrhœa (Gr. ἀ, neg., μήν, *a month*, and ῥέω, *I flow*). Morbid irregularity or deficiency of the menstrual discharge.

Amentaceous. Bearing amenta, or catkins; a name formerly applied in Systematic Botany to such plants as have their flowers arranged in amenta; but as very different kinds of structure were combined by this character, the order *Amentaceæ* of Jussieu is broken up into several others, the chief of which are *Betulaceæ* and *Salicaceæ*; and the term is now little used.

Amenthes. In Mythology, the kingdom of the dead, or Tartarus of the ancient Egyptians.

Amentum (Lat. amentum, *a thong*, or *loop*). A kind of inflorescence such as is found on willows and poplars; it differs from a spike in being deciduous.

Amerciament (from the French *merci*). The pecuniary punishment of an offender against the king or other lord in his court, when by his offence he is said to stand at the mercy of the king or lord.

America. The general physical geography of this vast and important tract of land will be most conveniently considered under the three divisions, *North*, *Central*, and *South America*. The chief mountain chains, river systems, and lakes will form the subject of separate articles; some of the special phenomena of the surface, such as *silvas*, *llanos*, *pampas*, are also described under their respective heads.

America, North. According to the most natural division of the continent North America begins north of the Gulf of Mexico in about 30° north latitude, and terminates in the Arctic Ocean. Its greatest length thus considered is nearly 4,000 miles, and its breadth at the widest part is about 3,500 miles. Its shape would be triangular and regular but for the

projecting peninsula of Florida. The eastern coast is deeply indented by bays, gulfs, and inlets. The western coast has the long and narrow peninsula of California, and the projecting Aleutian or Fox Islands, besides Vancouver's Land, but is not otherwise broken.

North America has two principal mountain ranges, the *Rocky Mountains* and the *Alleghanies*. It presents also a remarkable chain of lakes, the largest in the world, and several very important rivers connected with great river systems. Its bays and gulfs are among the most important that exist, and its plains [SAVANNAHS] are on a very grand scale. The descriptive and political geography of this vast and important continent are subjects that do not come within the scope of the present work. The climate of North America belongs to another article.

Mountain Systems.—A triple chain of mountains converging towards and terminating in the lofty plateau of Mexico forms the western boundary of North America. Of these the sierras, or lofty ridges, that extend into and form the Californian peninsula, commencing near Vancouver's Island, form the actual coast line. Within this there is a second coast range of some importance, broken by very wide gaps. This range extends quite to the Arctic Sea. Lastly, there is the great and lofty system of the ROCKY MOUNTAINS [which see]. Between the coast range and this latter mountain system are the great gold-bearing districts of Oregon and California, chiefly consisting of gravels brought down from the higher mountains, and deposited in the narrow valleys that are formed between them and the coast range. Many parts of the main chain are volcanic. At about the 40th parallel of north latitude, or between California and Oregon, all the great chains are crossed by a transverse range, and it is not unlikely that the mountains thus formed, which attain in each chain an elevation exceeding 10,000 feet, govern in some respects the distribution of the gold deposits.

The extreme western coast range, broken at Vancouver's Island, is continued further to the north, and culminates in the very lofty mountain called St. Elias, which is nearly 18,000 feet high: near it is another mountain 16,000 feet high. At this point, beyond it to the northwest, and for some distance to the south, the country is volcanic, but there are no recent volcanic cones between Oregon and Mexico.

The snowy mountains of the transverse ridges above mentioned, separating the gold fields of Oregon and California, are succeeded to the south by a great sandy plain watered by the Colorado. At the head of the Gulf of California the chain becomes again important, and continues into Mexico.

Between the great triple range on the west coast and the Alleghanies (which in like manner is a triple but very much lower chain, parallel to the east coast of North America) are the great plains or prairies, the vast desert surrounding the Salt Lake of the Mormons, and the low lands drained by the Mississippi and its tributaries. To the north are the great lakes and the valley of the St. Lawrence, and still further to the north the plains towards the Arctic Ocean, broken by Hudson's Bay. The eastern chain, which extends at intervals from Texas to Labrador, ranges only from 1500 to 2500 feet above the sea, and at various places admits of the passage of the rivers. [ALLEGHANIES.]

Lakes.—The principal North American lakes are five, communicating by the St. Lawrence with the Atlantic. They cover an area of more than 120,000 square miles, which is nearly half the total area covered with fresh water on the globe. Besides these five are several others, also very large, extending to the west and north, and communicating by Mackenzie River with the Arctic Ocean.

Of the great lakes, Superior is the largest, but Michigan the longest, the former being 460 and the latter 480 miles in extreme length. The areas are respectively 42,000 and 32,000 square miles. Both are deep, their mean depth being estimated at 900 and 1000 feet respectively. The volume of water is thus nearly the same. Lake Superior is 596, and Michigan 578 feet above the Atlantic. Lake Huron is the next in point of dimensions, measuring 275 miles by 92, and having an area of 27,500 square miles with a depth of 1000 feet. The others are much smaller and shallower. The whole group of the North American lakes would appear to have reference to the physical geography and geological structure of the northern part of the land of North America, and the present relations of that land with the Arctic Sea. The lakes occupy depressions on a table land of vast extent, gradually but steadily sloping towards the north. Those of the southern or main group are separated by a watershed of comparatively low lands, or by plateaux of moderate elevation, from the great drainage of the Mississippi on the one hand, and from the drainage of the Mackenzie on the other.

A very small geological change has produced, and an equally small geological change of another kind would at once put an end to, this condition. The extent of the basin drained by the lakes is estimated at upwards of 300,000 square miles of country.

River Systems.—The chief river systems of North America are, (1) the Mississippi-Missouri, draining into the Gulf of Mexico; (2) the St. Lawrence and great lakes, draining into the Atlantic; (3) the Mackenzie, draining into the Arctic Sea. There are several smaller systems, some opening into the Atlantic, but most of them into Hudson's Bay.

The Mississippi drains the great central basin of North America, and collects the waters of the Missouri, the Ohio, the Arkansas, and the Red River. The total length of course (including the winding of the principal stream) is estimated at 4000 miles, and the drainage area at 1,250,000 square miles. The Amazons

alone rivals this gigantic stream, but the Mississippi course being almost entirely in temperate latitudes, the importance of its stream to man is much the greater. The Mississippi and its tributaries may be said to drain the whole country between the two principal mountain chains of North America south of the transverse plateau, extending to the south-east from between Oregon and California.

A number of important but little known rivers drain the country to the north and west of this same dividing range, and enter Hudson's Bay at various points. The Mackenzie completes the drainage of the north of the continent, and the course of all these streams is broken by numerous large lakes. The St. Lawrence and the system of great lakes may be said to form an outlet for the rest of the water falling on the North American continent. None approach in length of course, or in area of drainage, the proportions of the great Father of Waters (Mississippi). The course of the St. Lawrence is estimated at 2000 miles, including windings, and the drainage area is 400,000 square miles.

Plateaux and Low Plains.—The great central plain of North America is a very remarkable feature in the physical geography of the New World. Reaching from the Gulf of Mexico to the Arctic Ocean, it includes the valleys of all the principal rivers, and occupies an area of more than 4,000,000 square miles.

This great expanse is widest towards the north, and has no elevation interrupting it except a low plateau near the Canadian lakes, forming the watershed between the streams entering the Arctic Ocean and those which proceed to the Gulf of Mexico or the Atlantic. The elevation above the sea is for the most part only about 700 feet, and nowhere exceeds 1500 feet. The land slopes gradually towards the plateau from both extremities of the continent, and for the most part it is wonderfully rich and fertile.

The southern part of the plain, having the advantage of a sub-tropical climate and much rain, is extremely productive when cultivated. It includes the *savannahs* of the Mississippi and some monotonous tracts of sand covered only with pines. To these succeed the *prairies* of the north-west, which are well watered. The plains of Canada and the other countries to the north are also rich, but have a less genial climate.

A wide and rich tract of low plains extends between the Alleghanies and the Atlantic seaboard.

AMERICA, CENTRAL. Under this name we include the table land of Mexico, continued in a narrow belt of land to the south-east, from which rise the volcanic mountains of Guatemala. These mountains, continued in the Isthmus of Panama, connect the northern mountains with the great mountain chain of the Andes. Of this district Mexico affords the largest tract of land. It has a river system and mountain chains, but no lakes of great magnitude. The northern part of the tract is often regarded as a part of North America.

Table Land.—The great table land of Mexico begins at Tehuantepec, where is a narrow neck or isthmus distinct from that of Panama, and it extends towards the north-west into North America, constantly expanding. At the city of Mexico, the breadth is about 400 miles, and it is there 7500 feet above the sea. It rises very abruptly on all sides, but the top is divided into four broad plains, surrounded by hills a thousand feet high. On one of these stands the city of Mexico.

The greater part of the table land of Central America is broken by crevices or barrancas, many of which lay bare volcanic phenomena, and a line of active volcanos extends near the city of Mexico from the shores of the gulf to the Pacific.

Another important table land is that of Guatemala. It is volcanic, and occupies the entire space between the Isthmus of Tehuantepec and that of Panama. Nearly forty volcanic mountains appear in this narrow space, at elevations varying from three to thirteen thousand feet above the sea. The loftiest mountain in Mexico (Popocatepetl) is also volcanic, and is nearly 18,000 feet above the sea. It is in a state of almost constant eruption.

Central America connects the Rocky Mountains with the Andes. The whole northern tract may be regarded as a broad-topped mountain chain, about 100 miles wide towards the north-west, but narrowing very greatly, and becoming a mere ridge towards the south-east. The great silver mines of Mexico are in the higher part of the table land, where it passes into the mountain chain. They extend towards the summits of the higher mountains.

River Systems.—The Rio del Norte is the only important river of Central America, and it drains only the northern district. It has a total length of two thousand miles, (including all windings,) and drains a quarter of a million of square miles of country, entering the Gulf of Mexico at about 25° north latitude. A number of small lakes occur on the table land at various elevations, and streams from them enter the Gulf of Mexico and the Pacific.

AMERICA, SOUTH. The greatest length of South America, from Cape Hoorn or Horn to the Isthmus of Panama, is about 4700 miles, and its extreme width is 3200 miles. Triangular in form, like so many of the principal tracts of land on the earth, its northern half is partly enclosed between the great chain of the Andes running along the west coast, and the less important mountains of Brazil in the north-east, and Venezuela in the north. The rest of the continent consists of vast plains at various elevations, chiefly in terraces. It is drained by some of the largest river systems on the earth.

South America is extremely remarkable for its great mountain chain of the ANDES, described in a separate article, for its gigantic rivers, and for its singular plains, some of which, under

the names of PAMPAS, LLANOS, SILVAS, are also noticed separately.

Mountain Systems.—The chain of the Andes commences at the Isthmus of Panama, and ranges close to the coast, at first in a double or triple line, and afterwards in a single chain to the furthest extremity of the continent, and so southwards into the ocean. It is almost everywhere volcanic. Generally close to the shore of the Pacific there is only a narrow strip of land on the slopes available for vegetation, and owing to the clouds being chiefly attracted to the mountains, and the rain conducted into the drainage of the eastern slopes, scarcely any rain falls along the greater part of this coast. (See ANDES.) The Organ Mountains in Brazil are parts of a complicated mountain system towards the north-eastern part of the Continent.

Table Lands.—Among the mountains in the northern part of the continent, and between the parallel chains, there are a few very lofty table lands. There are others in those places where the parallel ridges are connected by short transverse mountain chains, forming what are called *knots*. On these lofty elevations, some of them more than twelve thousand feet above the sea, are large and populous cities surrounded by cultivated tracts and numerous villages. These existed as centres of civilisation long before the Spaniards discovered and settled in the country. One of them is four hundred miles in length, with a breadth varying from 30 to 60 miles, and is situated in the Bolivian Andes. It occupies 150,000 square miles. It is a remarkable mining district, and is well peopled. On it is the Lake of Titicaca, about twenty times the area of the Lake of Geneva, the level of its waters being not less than 13,000 feet above the sea. Mountains rise from these enormous elevations, as from the plains of Switzerland, and to nearly as great an elevation above the plains.

The low lands on the east of the Andes are divided by table lands and mountains into three parts, the PAMPAS of Patagonia and Buenos Ayres, the SILVAS of the Amazons, and the LLANOS of the Orinoco. [See these articles.] The eastern mountains beyond these, and the chains to the north, are far less elevated than the Andes, and comprise several chains of no great elevation.

River Systems.—Of all the river systems and rivers of South America, that of the Amazons is the most gigantic, and the most interesting. Taking its rise in Upper Peru at a very great elevation, it proceeds, under the name of Marañon, in a deep north and south valley, till it bursts through the eastern ridge, when it at once takes a new course towards the east, and continues with the same bearing for nearly four thousand miles, till it enters the Atlantic without delta, conveying its tribute unbroken to the ocean. It receives tributaries proportioned to its magnitude and importance. More than twenty noble rivers, all navigable almost to their sources, pour their waters into it: some of them are a mile wide at their junction, and have separate courses of more than a thousand miles. Innumerable islands are formed by it during its course, and its depth is generally very great. Its waters discolour the ocean to a distance of more than three hundred miles from the mouth of the river. The Amazons is subject to inundation, the water rising in December, attaining its greatest height in March, and falling till July and August, when it is lowest. The Amazons is considered to drain at least two millions of square miles of country.

The Rio de la Plata, or Plate River, is only less gigantic than the Amazons. For 200 miles from its mouth it is never less than 170 miles broad, and one of its tributaries, the Paraguay, may be ascended by vessels of considerable burden, through 19° of latitude above its junction with the main stream. The principal stream of the Plata rises in Brazil, and runs for 500 miles on the table land towards the south before taking its main course. It then falls over a hundred miles of rapids and cataracts, and continues with an easterly course under the name of the Paraná, receiving three large rivers. Before reaching the Atlantic, it receives the waters of the Uruguay. The whole stream is subject to extreme floods, the ordinary inundations covering many thousand square miles, and the extraordinary desolating whole provinces.

The Orinoco is the third gigantic river of South America. Rising in the Andes like the others, it first runs north, and then, combining with other large streams, turns eastward. A part of its waters joins the Amazons, the two rivers thus interlacing by a natural canal. It drains an area of 300,000 square miles, of which the upper part is impenetrable forest. It is navigable for 1,000 miles above its mouth, and receives many navigable rivers. Like the other rivers proceeding from the Andes and crossing South America, it is subject to floods, which are more regular than those of the Amazons and Orinoco.

There are many other large and important rivers in South America, some entering the Caribbean Sea, but most of them crossing the continent. They are more connected and less separated by mountain chains than the river systems of other countries, and almost alone among the great rivers of the world they exhibit the phenomena of *anastomosis*, or the existence in some part of their course of natural channels connecting their waters. [RIVER SYSTEMS.]

Ametabolia (Gr. ἀ, *without*, and μεταβολή, *change*). A sub-class of insects which do not undergo any metamorphosis.

Amethyst. A purple variety of Rock Crystal, the finest kinds of which are found in Brazil, India, Ceylon, Persia, Morocco and Siberia; but it also occurs in Ireland, Auvergne in France, Spain, Saxony, Hungary, Transylvania, the Harz, &c. The name ἀμέθυστος (from ἀ, neg., and μεθύσκω, *to inebriate*), was given to

it by the ancient Greeks from some influence the stone was supposed to exercise in preventing those who wore it from becoming intoxicated.

Amia. The name of a Linnæan genus of abdominal fishes, founded on a single species (*Amia calva* Linn.), native of the freshwater streams of Carolina, North America, and which is still its sole representative. It is an example of the Sauroid fishes of Agassiz, and is remarkable for the cellular structure of its air-bladder, which, as Cuvier remarks, is similar to the lung of a reptile.

Amiantholde. A variety of Amianthus from Oisans, in Dauphiny, the fibres of which are somewhat elastic.

Amianthus, or Mountain Flax (Gr. ἀμίαντος, *undefiled*). A term applied to the more delicate kinds of Asbestos, in consequence of the simple manner by which, when soiled, it may be restored to its original purity by the action of fire. The cloths in which the ancients wrapped the dead bodies of persons of distinction, before they were burned on the funeral pile, are supposed to have been made of this substance. By this means they were enabled to collect the ashes and unconsumed bones for subsequent inhumation in vases, free from any admixture of extraneous matters. Amianthus is chiefly found in cavities of the older crystalline rocks, in the alps of Dauphiny and Switzerland, in the Pyrenees, Greenland, N. America, &c. It is also met with in the granular limestone and serpentine of Sweden, the Ural, Silesia, and New South Wales.

Amicable Numbers. Two numbers are said to be *amicable* when each is equal to the sum of the aliquot parts of the other. The first or least pair of amicable numbers are 220 and 284: they were found by E. Schooten, with whom the name *amicable* appears to have originated, though Rudolphus and Descartes were previously acquainted with this property of certain numbers. A formula for amicable numbers was, in fact, given by Descartes and afterwards generalised by Euler and others.

Amictus or **Amice** (Lat.). Any upper garment worn by the Romans over the tunic. It is also a square piece of linen worn over the shoulders by Roman Catholic priests.

Amides. Compounds containing a base apparently composed of one atom of nitrogen, and two of hydrogen.

Amidin. The soluble part of starch.

Amido-acids. Organic acids which are formed by the union of one equivalent of the hydrate of a dibasic acid and one equivalent of ammonia, two equivalents of water being expelled.

Amidogen (the generator of *amides*). A compound of one atom of nitrogen and two atoms of hydrogen: this compound has not been isolated, but may be traced in combination with other substances, constituting compounds called *amides*: thus *potassiamide* is a compound of the metal potassium with amidogen; and, in reference to the same view, ammonia [which see] is an amide of hydrogen. Amidogen is thus represented by the symbol $N\,H_2$, and ammonia as $= N\,H_2 + H$, or $N\,H_3$.

Amid-ships. A nautical term, denoting the middle of the ship, either with respect to her length or breadth.

Amines. Chemical substances resembling amides and amido-acids in constitution, but containing electro-positive or basic radicals. They are monamines, diamines, or triamines according as they are derived from a single, double, or triple atom of ammonia, and are primary, secondary, or tertiary, according as one-third, two-thirds, or the whole of the hydrogen is replaced by radicals.

Amisatine. A crystalline body derived from indigo.

Ammelide. A white neutral chemical compound derived from ammeline by the action of strong acids.

Ammeline. A white crystalline feebly basic substance, resulting from the action of acids or alkalis upon melam.

Ammiolite (Gr. ἄμμιον, *vermilion*). An antimonide of mercury mixed with clay and oxide of iron, forming a red powder. It is found at the quicksilver mines in Chili, and at Silbe in Westphalia.

Ammocœtes (Gr. ἄμμος, *sand*, and κοίτη, *a bed*). The name of a genus of Cyclostomous fishes, of which the 'pride,' or 'stone grig' (*Amm. branchialis*), is a well-known example. This fish buries itself in the sand or clay of the banks of rivers, has many of the habits of a worm, possesses a skeleton reduced to membranous consistence, and ranks amongst the lowest of organised vertebral animals.

Ammodytes (Gr. ἀμμοδύτης, *a sand burrower*). The name of a Linnæan genus of apodal fishes, characterised by a compressed head, narrower than the body; and both elongated. Gill-openings large, with seven branchiostegal rays; dorsal fin extending nearly the whole length of the back; anal fin of considerable length; dorsal and anal fins separated from the caudal fin. The sand eel (*Ammodytes tobianus* Linn.) and the sand-launce (*Ammodytes lancea* Cuv.) are examples of this genus.

Ammon. In Mythology, apparently a Libyan divinity, adopted by the Greeks, and by them identified with their Jupiter.

> —— stat corniger illic
> Jupiter, ut memorant, sed non aut fulmina vibrans,
> Aut similis nostro, sed tortis cornibus Ammon.
> LUCAN, *Pharsal.* ix. 510.

The name has been derived from ἄμμος, *sand*, to which the situation of his temple in an oasis, surrounded by African deserts, might seem to point: but Herodotus (ii. 42) identifies the name with the Egyptian Amoun. Alexander visited the temple, and assumed the title of son of this divinity, in order to impose on oriental imagination. It possessed a celebrated oracle.

Ammonia. Volatile alkali. This important compound is chiefly produced artificially. It

exists, combined with acids, in some of the saline products of volcanos, and, in very small quantities, is discoverable in sea-water. It is found in putrid urine, and in the salts produced by the decomposition of animal matter; it exists occasionally in very minute quantities in the air, especially in large towns where pit-coal is burned; and the small stellated crystals which are sometimes observed on dirty windows in London, consist of sulphate of ammonia.

Ammonia was originally obtained (in the form of muriate of ammonia) by burning the dung of camels, which was collected for the purpose in Egypt, especially about the temple of Jupiter Ammon (whence the term sal ammoniac). It was afterwards procured by the distillation of putrid urine. At present, the demand for ammonia in its various states and combinations is in this country chiefly supplied from two sources —the distillation of pit-coal, and that of refuse animal substances, such as bone, clippings and shavings of horn, hoof, &c.

When coal is distilled [GAS], a large quantity of ammoniacal liquor, as it is called, is formed, to which sulphuric or muriatic acids are added so as to form a sulphate or a muriate of ammonia. When the animal substances just mentioned are distilled, a quantity of impure ammonia passes off with the other products, which is also converted into sulphate or muriate of ammonia.

Pure ammonia is obtained in the form of a gas, by heating a mixture of quicklime and muriate of ammonia. It is very pungent and acrid; and so soluble, that one measure of water absorbs nearly 500 of gaseous ammonia: this solution is known under the name of liquid ammonia, and is used in medicine. Ammonia is a compound of nitrogen and hydrogen; it consists of

Nitrogen	1 atom	=	14	82·35
Hydrogen	3 ,,	=	3	17·65
	1		17	100·00

It is decomposed when passed through a red-hot tube, and every 100 volumes of ammonia are resolved into 200 volumes of a mixture of 3 volumes of hydrogen and 1 of nitrogen.

Carbonate of ammonia is used in medicine as a stimulant, and frequently employed, under the name of smelling salt, as a restorative in faintness. It is obtained by sublimation from a mixture of muriate of ammonia and carbonate of lime. Muriate of ammonia has been above referred to as the common source of pure ammonia. Sulphate of ammonia is also manufactured for the same purposes.

Ammonia is recognised by its pungent smell, by its transient alkaline effect upon vegetable colours, and by producing white fumes when approached by muriatic acid. Thus, if we burn a piece of quill, and hold a glass rod dipped in muriatic acid near the smoke of it, dense white fumes appear, announcing the presence of ammonia, formed by the action of heat upon the animal matter.

Ammonia-alum. A hydrated sulphate of alumina and ammonia, found in thin layers and in octahedrons, in Brown Coal, at Tschermig in Bohemia. An alum in which the potash of common alum is replaced by ammonia is now in common use.

Ammoniacum. A gum resin used in medicine: it is imported in drops and cakes from Africa and the East Indies, and is said to be the produce of the *Dorema ammoniacum.* It is of a pale buff colour, and stands in the materia medica among the mildly stimulating but uncertain expectorants. It is sometimes applied externally in the form of a plaster.

Ammonites. An extinct genus of molluscous animals which inhabited convoluted chambered siphoniferous shells, sometimes called Cornua ammonis, and vulgarly snake stones. From their affinity to the nautilites, and the known organisation of the animal of the pearly nautilus, fossil shells of this genus are referred to the Tetrabranchiate order of Cephalopods, and constitute the typical genus of the second family of that order (*Ammonitidæ*). They are characterised by their conspicuous whorls, and the marginal-external position of the siphon. They abound in the strata of the secondary formation, varying from the size of a bean to the dimensions of a coach-wheel. Their name is derived from their resemblance to the horns upon the statue of Jupiter Ammon.

Ammonitidæ. A family of Cephalopods, with chambered siphoniferous shells, characterised by the septa being sinuous, with lobated margins. The species of Ammonitidæ exceed 500, and their range is coeval with the secondary rocks.

Ammonium. The hypothetical metal supposed to exist in the salts of ammonia. Ammonium is the analogue of potassium and sodium, the known metals contained in the salts of the fixed alkalis. It has never been obtained in the free state, the nearest approach to isolation being a light spongy amalgam formed by double decomposition of chloride of ammonium and an amalgam of sodium.

Ammophila (Gr. ἄμμος, *sand*, and φιλέω, *I love*). The name of a genus of Hymenopterous insects, called sand-wasps. The generic characters are, proboscis conic, inflected, concealing a bifid, retractile, tubular tongue; jaws forcipated, three-toothed at the tip; antennæ filiform in each sex, with about fourteen articulations; eyes oval; wings plane; sting pungent, concealed within the abdomen.

Ammunition. In Military Language, signifies all sorts of warlike stores and provisions, but more especially powder and ball.

Amnesty (Gr. ἀμνηστία, *oblivion*). In Politics, freedom from penalty, granted by a solemn act to those guilty of some crime. Usually, by an act of amnesty is meant one passed to comprehend a number of individuals guilty of offences of a political nature, as rebellion, &c. Among remarkable amnesties in modern European history, may be cited that granted on the restoration of Charles II., from

which were excepted those concerned in the death of Charles I.; that granted on the second restoration of the Bourbons, in January 1816, from which, besides the regicides, several others were excepted by name; and the law of amnesty for political offences in France in 1836. An article of amnesty generally forms part of the treaty which concludes a war. (Phillimore on *International Law*, vol. iii. 559.)

Amnion (Gr.). The membrane which surrounds the fœtus in utero: it includes a thin watery fluid, the liquor amnii.

Amnios. In Botany, a thin semitransparent gelatinous substance in which the embryo of a seed is suspended when it first appears, and on which the embryo appears to feed in its early stages. Sometimes it is wholly absorbed; sometimes a portion of it is solidified in the form of albumen; occasionally, as in the cocoa-nut, a portion is consolidated into albumen, and a portion remains always in a fluid state. The large cell in which the amnios is secreted sometimes becomes thickened and assumes the form of a bag including the embryo, and called Vitellus, as in *Piper*.

Amniotic Acid. An acid supposed to be peculiar to the liquor amnii of the cow, but now known to belong to the liquor of the allantois.

Amœba (Gr. ἀμοιβή, *alternation*). The *Amœba diffluens* of Ehrenberg is the lowest organised Acrite of the order *Rhizopoda* with which zoologists are acquainted. It is a mere gelatinous mass of rounded form, capable of emitting processes and lobes from all parts of its body, which are drawn in again at will. It has been suggested that it forms a temporary or embryonic form of higher *Rhizopoda*.

Amomeæ. [AMOMUM.] One of the names of the plants more commonly called *Zingiberaceæ*.

Amomum (hhamâmâ, Arabic; ἄμωμον, of the Greeks). A Zingiberaceous plant, with aromatic seeds, much employed under the name of cardamoms, grains of Paradise, &c. The species occur exclusively in the hot parts of India and Africa.

Amorphous (Gr. ἄμορφος, *without form*). A term used in Geology in reference to rocks not crystallizing in definite form. Thus we have amorphous limestone or sandstone, in contradistinction to crystalline limestones and quartz rock. A very large proportion of rocks are of this kind, distinct crystallization being a rare exception. Even the crystalline rocks, such as granite, may be regarded as amorphous in this technical sense of the word.

AMORPHOUS. In Mineralogy, amorphous minerals are those which present no definite or definable forms.

Amorphozoa (Gr. ἀ, priv., μορφή, *shape*, ζῶον, *animal*). The lowest organised class of Protozoa, or Acrita. It comprehends the orders: 1. Porifera (sponges); 2. Desmidiæ; 3. Diatomaceæ; 4. Gregarinidæ. [ACRITA and SPONGES.]

Amortisation or **Amortisement** (Fr. amortissement). In Law, an alienation of lands in mortmain to some guild or fraternity which in its corporate capacity can never cease.

Ampelic Acid. One of the white solids produced by the action of nitric acid on coal tar.

Ampelidæ (Gr. ἄμπελος, *a vine*). In Botany one of the names of the natural order *Vitaceæ*.

Ampelin. A liquid resembling creasote, contained in coal tar.

Ampelis. The name of a Linnæan genus of Passerine birds, characterised by a straight convex beak, of which the upper mandible is the longer, and is subincurved, and emarginate on both sides. The Bohemian chatterer, or waxwing (*Ampelis garrulus* Linn.), is a well known species of this genus; but is referred in the recent systems of Ornithology to a distinct section or subgenus, retaining the name of Bombycilla, originally applied to it by Brisson.

Amphiarthrosis (Gr. ἀμφίς, *on both sides*, ἄρθρον, *joint*). A kind of articulation in which motion is scarcely allowed to the surfaces of the bones composing it. The metacarpal, metatarsal, and spinal articulations are examples.

Amphibians, Amphibia (Gr. ἀμφίβιος, *having the faculty of existing both in water and on land*). In modern Zoology, this term is restricted in its application to those animals which possess organs for breathing water, and organs for breathing air, or gills and lungs conjointly. Many cold-blooded animals, from the slowness of their circulation and the great capacity of their lungs in proportion to the vascular surface which alters the chemical state of the contained air, can remain a long time under water without being necessitated to seek the surface for a fresh supply: such are all the vertebrata called Reptilia by modern zoologists, and which Linnæus, from the above mentioned faculty, included under the term Amphibia: yet if these animals were kept submersed longer than the period necessary for renewing the air in their lungs, they would inevitably be drowned; they are, therefore, not strictly amphibious. Not so, however, with that small portion of the order which retain their branchiæ throughout life; these perennibranchiate reptiles suffer nothing from a prolonged aquatic existence, but, on the contrary, are most affected by a too long continuance on dry land; a desiccation of their external fringed gills, according to experiments on the *Siren lacertina*, occasioning their death. Those warm-blooded mammalia which have their general form and locomotive instruments adapted for aquatic life, as whales, porpoises, walrusses, and seals, are, from the rapidity of their circulation and the prodigious extent of the vascular and respiratory membrane of the lungs, still more dependent upon a fresh supply of air for their existence than the pulmonated reptiles, and are consequently further removed from a true amphibious organisation. This is, in fact, enjoyed

by a very small proportion of the animal kingdom. Besides the perennibranchiate reptiles, a few species of mollusca, as the Ampullaria, and some insects and crustaceans, are the only examples.

Amphibiolite (Gr. ἀμφίβιος, and λίθος, *a stone*). The name given by Linnæus to parts of reptiles, or amphibia, changed to a fossil substance.

Amphibole (Gr. ἀμφίβολος, *equivocal*). A name applied by Haüy and some other mineralogists to Hornblende, on account of its resemblance to Augite, for which it may be mistaken.

Amphiboli. In Ornithology, the name of a family of scansorial birds, in the system of Illiger, including those in which the external posterior toe is versatile.

Amphibology (Gr. ἀμφίβολος, *doubtful*, and λόγος, *discourse*). In Rhetoric, an equivocal phrase or sentence, of which the sense may bear more than one interpretation.

Amphicœlian (Gr. ἀμφίς, *on both sides*, and κοῖλος, *concave*). The term used when both articular surfaces of the centra of vertebræ are concave, a character found in fishes, as well as in many Batrachia, and in the extinct sea-lizards (*Enaliosauria*) of the secondary period. In inverse proportion to the degree of ossification of the notochord is the depth of the cups filled by the gelatinous intervertebral substance.

Amphictyonic Council (Gr. ἀμφικτύονες, from the hero Amphictyon; but in its origin the word was doubtless ἀμφικτίονες, *dwellers round about*). A council of confederated tribes. There were several in Greece, but the most important was a congress of the deputies of twelve northern Greek tribes, viz. Thessalians, Bœotians, Dorians, Ionians, Perrhæbians, Magnetes, Locrians, Œnianians, Achæans of Phthia, Malians, Phocians, and Dolopians, or Delphians. In the Dorians and Ionians were included the Lacedæmonians and Athenians, who each sent one deputy. Each of these tribes had two representatives in the council called the Hieromnemon and Pylagoras. The congress met twice every year; in the spring at Delphi, and at Thermopylæ in the autumn. Its functions were chiefly directed to religious matters, and more especially the protection of the temple of the Delphian Apollo. The principal ancient authorities which we possess respecting the objects and constitution of the amphictyonic council are to be found in the orations of Æschines and Demosthenes; the 16th book of Diodorus Siculus; 9th of Strabo; and 10th of Pausanias. See also Ant. Van. Dale's *Dissertationes*, Amst. 1702; Papers by Valois, in the *Mém. de l'Ac. des Inscriptions, &c.*, iii. 191, v. 405; St. Croix, *Des Gouvernemens Fédératifs*; Müller, *Hist. of the Dorians*; Grote, *Hist. of Greece*; Freeman, *History of Federal Government*.

Amphicyon (Gr. ἀμφίς, *on both sides*, and κύων, *dog*). A genus of plantigrade carnivorous mammalia allied to the Wah (*Ailurus*), found in the miocene deposits at Eppelsheim, near Darmstadt, and at Sausan, in the South of France. Like most of the fossil carnassial and herbivorous animals of the lower tertiary age, it retained the perfect type of diphyodont dentition. [DIPHYODONT.]

Amphigamous. The most imperfect of all plants, having, as was formerly thought, no trace whatever of sexual organs.

Amphilestes (Gr. ἀμφίς, *on both sides*, and λῃστής, *thief*). A genus of insectivorous mammalia, found with *Amphitherium* in the oolite. It is, however, generically distinct from that genus.

Amphioxus (Gr. ἀμφί, and ὀξύς, *sharp*). The name of a genus of fishes, so called because the animal is sharp at both ends. It is recognised as a vertebrate animal only by its gelatinous dorsal chord, which supports a medullary spinal chord or nervous axis, and gives attachment to segmental partitions.

Amphipneusts (Gr. ἀμφίς, *on both sides*, and πνέω, *I breathe*). Merrem so calls a tribe of reptiles, comprehending those which have both lungs and gills.

Amphipods (Gr. ἀμφίς, *on both sides*, and πούς, *a foot*; *feet diversely conformed*). The third order of Crustaceans in Latreille's arrangement, and the only one in which subcaudal natatory feet co-exist with sessile eyes.

Amphiprostyle (Gr. ἀμφιπρόστυλος). A term applied by writers on architecture to a temple having a detached row of four columns on the front and back elevations. It is assumed that Vitruvius uses the term to mean a temple without any columns on the sides, and with only a posterior and an anterior portico.

Amphisbæna (Gr. ἀμφίσβαινα). A genus of serpents or ophidian reptiles in which the tail and head are equally obtuse, and the scales of the head so similar to those on the back as to render it difficult, on a cursory inspection, to distinguish one extremity of the body from the other. Hence these reptiles have been supposed to have the power of creeping backwards or forwards with equal facility.

Amphiscians (Gr. ἀμφίσκιος, from σκία, *shadow*). A term used by the ancient geographers, to denote the inhabitants of those climates in which the shadows, at noon-day, fall in opposite directions at different times of the year; that is to say, towards the north when the sun at noon is to the south of their zenith, and towards the south when the sun is to the north of their zenith. The term, consequently, applies to the people who live between the tropics.

Amphitheatre (Gr. ἀμφιθέατρον). A large edifice for scenic representations, gladiatorial or other fights, of a circular or an elliptical form, so as to allow the whole of the spectacle to be witnessed by all the spectators. The Colosseum at Rome, the amphitheatres of Verona, Nimes, Metz, &c., may be cited as examples of this class of buildings. They are usually open to the sky: they have a large, open, and level space in the centre, with seats rising all round,

provided with the necessary staircases, passages, exists, and entrances, and with cellars in which the beasts, or the prisoners condemned to be slaughtered for the amusement of the public, were confined. Amphitheatres were never built by the Greeks during the period of their independence, but they seem to have been an essential part of Roman social organisation, for they were erected wherever that nation established itself permanently, and even in England their ruins are to be seen. Consult Maffei, *Amphitheatre*; Cresy, *Encyclopædia of Engineering*; Viollet le Duc, *Dictionnaire d'Architecture.*

Amphitherium (ἀμφίς, *on both sides*, and θηρίον, *beast*). A genus of fossil insectivorous mammalia which is found in the oolitic deposits at Stonesfield, in Oxfordshire. The *Amphitherium Prevostii*, which forms the solitary species, has been erroneously supposed to be a marsupial, but the limited extent of the angular inflection of the jaw turns the scale in favour of its affinity to the placental *Insectivora.* It nevertheless offers many points of analogy with the remarkable marsupial genus *Myrmecobius*, which still exists in Australia.

Amphitrite (Gr.). In Greek Mythology, a daughter of Nereus or Oceanus, and a wife of Poseidon, the god of the sea. In Homer Amphitrite is simply a name for the sea: but in the Hymn to Apollo she is a personal being, and present at the birth of the son of Leto. (Hesiod, *Theog.* 243; Apollodorus, i, 2, 7.)

Amphitrite. In Zoology, the name of a genus of cephalo-branchiate or tubicular annelides, characterised by golden-coloured short bristles, arranged like a crown, in one or two rows, on the anterior part of the head. One species inhabits the south coast of England, and forms for its habitation a delicate conical tube of grains of sand, agglutinated together by the mucus exuded from the skin: this is the *Amphitrite auricoma.*

Amphitropal (Gr. ἀμφί, and τρέπω, *I turn*). In Botany, this is said of an embryo which is curved upon itself in such a manner that both its ends are presented to the same point.

Amphiuma (Gr. ἀμφί, and ὑμήν, *a membrane*). A genus of true amphibious reptiles, with a persistent branchial orifice on each side of the neck; palatal teeth in two longitudinal rows; a lengthened body, and four rudimental extremities, each divided either into three or two toes, according to the species.

Amphodelite. A reddish variety of Anorthite, occurring massive and crystallized in the form of Felspar at Lojo in Finland, and at Tunaberg in Sweden.

Amphora (Lat). In Sculpture and ornamental Architecture, a vessel having two handles, used as a measure for liquids by the Greeks and Romans: they are frequently applied as ornaments on sarcophagi, &c.

Amplexicaul (Lat. amplecto, *I embrace*, and caulis, *a stem*). A leaf or bract whose base projects on each side, so as to clasp the stem with its lobes.

Amplification. In Rhetoric, the lengthening a discourse or a passage by the enumeration of minute circumstances, the employment of epithets, particularity of description, &c., with a view to produce a deeper impression. *Exaggeration* is properly a species of amplification, in which circumstances and facts are not merely dwelt upon, but represented beyond their true dimensions.

Amplitude. In Astronomy, denotes the angular distance of a celestial body, at the time it rises or sets, from the east or west points of the horizon. The amplitude of a fixed star remains very nearly the same all the year round; that of the sun or moon is constantly changing. At a given latitude, it depends on the declination of the object.

In Mathematics, the term amplitude is frequently used to indicate the angle upon whose value that of some function depends. [Elliptic Functions.]

In Mechanics and Physics, the term is applied to oscillating and vibrating bodies, to indicate the distance, angular or otherwise, between the extreme positions assumed by the body. Thus, in the case of the pendulum, the *amplitude of oscillation* is the angle between the extreme positions of the line joining the centres of suspension and oscillation. In the case of liquid waves, the amplitude of oscillation of the several particles on the surface is the difference in level between the crest and trough of the wave.

In Gunnery, amplitude is sometimes used to denote the horizontal distance to which a projectile is expelled from a gun, or what is more frequently termed the range of the gun.

Ampulla (Lat.). In Anatomy, that end of each of the three semicircular canals of the internal organ of hearing which is more dilated than the other.

Ampulla. In Ecclesiastical History, one of the sacred vessels used at the altar, and at the coronation of monarchs.

Amulet (Low-Lat. amuletum). A substance worn about the person, and supposed to have the effect of protecting the wearer against some real or imaginary evils. Those of the Persians and Egyptians are said to have been small cylinders ornamented with figures and hieroglyphics. The Greeks and Romans employed for the same purpose a great variety of gems and small figures of deities, heroes, or animals, the bulla, and various other articles. Some of these were hung around the necks of children, to defend them from the evil eye. In more modern times, scraps of paper or parchment inscribed with verses of the Bible, or with magical characters and jargon, have often been used for the same purposes. The celebrated Arabian talismanic medals are called by the Arabs Ain, from the first letter of the inscription always beginning with that character.

Amygdaleæ (Gr. ἀμύγδαλον, *an almond*). A division of Rosaceous plants, comprehending the peach, the plum, the apricot, and similar

objects. The species have all a fleshy or succulent fruit, gum in their bark, and hydrocyanic acid is generally obtainable from their leaves. They occur principally in cold and temperate latitudes.

Amygdalic Acid. An organic acid derived from amygdalin, by assimilation of water and elimination of ammonia, under the influence of alkalis.

Amygdaline. A crystalline principle contained in the bitter almond, which, under the influence of *emulsine* and water, yields hydrocyanic acid, and the volatile oil of bitter almonds. By the action of certain bases amygdaline yields ammonia, and amygdalic acid. The composition of amygdaline is $C_{40}H_{27}O_{22}$.

Amygdaloid. In Geology, rocks are so called which have contained oval hollows now filled up with some crystalline mineral. They are all of the class of igneous rocks and of the nature of lava. The bubbles were originally occupied by gas or steam, and may have been round, but have become elongated by the flow of the molten rock before finally cooling.

Agate, chalcedony, calc-spar, and zeolites, are all found in the cavities of amygdaloid, and the basis may be basalt, greenstone, or any other kind of trap. The ordinary varieties are met with in districts where there is evidence of volcanic action at some distant period, but where at present, and within the historic period, there is nothing to indicate disturbance.

Amygdalus (Gr. ἀμύγδαλος). Small trees referred by some botanists to the *Rosaceæ*, and by some to a group separated therefrom and distinguished as the *Drupaceæ*. The genus includes the almond, *A. communis*, of which there are two very distinct varieties, the bitter and the sweet; and the peach, *A. persica*. The sweet almond tree, a native of Barbary and Morocco, is remarkable in early spring for its beautiful appearance when loaded with its pale pink flowers, and hence it is largely planted for purposes of ornament. The peach, of which the nectarine is a mere variety with a smooth skin, is considered by DeCandolle as a native of China. It is grown so extensively in America that the produce is sometimes used for feeding pigs.

Amyle or **Amylene.** This term applies in Chemistry to the hydrocarbon which is the basis of the so-called *Amylic alcohol*, or hydrated oxide of amyle. Amyle contains 10 atoms of carbon and 11 of hydrogen, and is represented, therefore, by the symbol $C_{10}\,H_{11}$. The volatile oil of potato-spirit (the *Fousil oil* of the Germans) includes this compound.

Amylamine. A light colourless inflammable liquid derived from ammonia by replacement of one of its three atoms of hydrogen by the radical amyle.

Amylic Alcohol. Derived from the fermentation of starch; hence the word *amylic*. Under the name of potato-oil or fusel oil, it is a product of fermentation in distilleries, and is contained in crude spirit. It has a powerful suffocating odour and nauseous taste, and its minimum production and subsequent removal are anxious objects of the distiller.

Amylurea. Urea in which hydrogen is replaced by the radical amyle.

Amyridaceæ. Balsamic exogenous shrubs or trees, found almost exclusively in the tropics. They have been called *Burseraceæ*. Olibanum and frankincense are produced by species of *Boswellia*; Myrrh, Balm of Mecca, and Bdellium by species of *Balsamodendron*; American Elemi, American Balm of Gilead, and Balsam of Acouchi by species of *Icica*; Resin of Cachibou and resin of Carana by species of *Bursera*: and part of the Gum Elemi of commerce is said to be the produce of *Amyris hexandra*. The genus *Amyris* (myrrha, *myrrh*) is the type of the order.

Amyrine. A resin contained in the white canary wood of the Philippine Islands.

Ana or ĀĀ (contracted from ana). In Medical prescriptions, implies 'of each.'

Anabaptists (from the Greek ἀναβαπτίζω, *to rebaptize*). In Ecclesiastical History, properly, all sects are so called that insist upon the repetition of baptism upon admission into their communion, from a notion of the invalidity of the religious ceremonies of other denominations. There were several such in the early period of the church, as the Cataphrygians and Novatians: but they are to be distinguished from the sects which arose in the fifteenth and the beginning of the sixteenth centuries, under the papal dominion, especially in Germany, and adopted, in their fanaticism, preposterous notions of the qualifications requisite for admission into the visible church. Their idea of primitive society consisted in the rejection of all the customs and decencies of life; in the community of goods and of women; in uncompromising hostility to all modes of artificial life, and to government generally as the foundation of social distinctions. They had of course no indulgence for the ordinances of any church but their own, and required baptism by themselves as the essential preliminary for admission within their pale. Early in the progress of the Reformation, finding their numbers daily increasing under the licentiousness of opinion which the unrestricted abuse of private judgment produced among a rude and uneducated people, they united in a hostile league against all existing institutions, and declared open war against the governments of Lower Germany. After committing the greatest atrocities, and causing an universal panic throughout Europe, their progress was arrested by a complete defeat in Saxony, in which their leader, Muncer, perished. The remnant, however, escaping, established their opinions with more or less moderation of tone in Holland and elsewhere. Some of the party seized soon after upon the town of Munster, overthrew the magistracy, and established society upon their own principles; but eventually were put down with great slaughter. (See as to the Munster Anabaptists, *Mosheim's Ecclesiastical History*, sect.

ii. part ii. c. 3, where reference is made to the best works on the subject.) [BAPTISTS.]

Anabas. A genus of Acanthopterygious fishes, in which the surface of the pharynx is broken into numerous little branched appendages and cells capable of retaining water and of gradually dropping it into the branchial cavity so as to moisten the gills; whereby these fishes have the curious faculty of voluntarily quitting the water, creeping about on land, and even, it is said, of climbing trees. The only known species (*Anabas testudineus*) is the *Perca scandens*, or climbing perch, of the older naturalists. [AMPHIBIA.]

Anabasis (Gr. *a going up*). The title of Xenophon's celebrated description of the expedition of the younger Cyrus against his brother, and of the retreat of the 'Ten thousand' Greeks.

Anableps (Gr. ἀναβλέπω, *I look up*). A name applied to a genus of Malacopterygian viviparous fishes, characterised by a remarkable projection of the eyes from the sides of the head, and a still more singular structure of the cornea and iris, from which there result two pupils, and the eyes appear to be double on each side, although they have but one crystalline lens, one vitreous humour, and one retina.

Anacanthini (Gr. ἀνά, *up*, ἄκανθα, *spine*). An order of fishes, distinguished by an ossified endoskeleton, the exoskeleton in some as cycloid, in others as ctenoid scales: fins supported by flexible or jointed rays; ventrals beneath the pectorals, or none; swim-bladder without air-duct. Many of the existing edible fishes belong to this order. It is divided into two suborders, the *Apodes* and the *Thoracici*. To the latter the families *Gadidæ* (the cods) and *Pleuronectidæ* (the flatfishes) belong.

Anacardiaceæ. A natural order of Exogens, founded upon the *Anacardium occidentale*, or Cashew nut. It consists of tropical trees, often abounding in a fluid resin of extreme acridity, but forming a valuable varnish in some cases. Marking nuts, the fruit of *Semecarpus anacardium*, black Burmese varnish obtained from *Melanorrhœa usitatissima*, mastich, Scio turpentine, pistacia nuts, and sumach, are all produced by various species of this order.

Anacardic Acid. An acrid fatty substance, found in the fruit of the *Anacardium occidentale*, or cashew nut.

Anachronism (Gr. ἀναχρονισμός). An inversion or disturbance in the order of time: as where, in Shakspeare's *King John*, cannon are introduced, which were not employed until 100 years later.

Anaclastics (Gr. ἀνάκλαστος, *reflected*). That part of Optics in which the refraction of light is considered, and which is commonly called Dioptrics. The term anaclastics was used by De Mairan, who investigated the apparent form of the bottom of a vessel when looked at through a body of water.

Anacoluthon (Gr. ἀνακόλουθον, *not following*). A Grammatical term, denoting the want of sequence in a sentence, one of whose members belongs to a different grammatical construction from the remainder. This figure occurs more frequently in the Greek than in any other language.

Anacolyppa. An Indian plant, the juice of which is used as a preservative against the poisonous effects of the bite of the cobra.

Anacreontic. In Poetry, a species of ode devoted chiefly to the praises of love and wine:—

> Quid nisi cum multo venerem confundere vino,
> Præcepit lyrici Teia musa senis?

The name is derived from Anacreon of Teos, who flourished in the sixth century B.C. The genuineness of the Odes which pass under his name is little believed, but some of them are, at all events, very ancient; and they have been universally admired for their sprightliness. The poems of Anacreon have been rendered familiar to the English reader by the translations of Cowley and Moore. The best editions of the original are those of Fischer and Brunck.

Anacyclus (Gr. ἀνακυκλέω, *to turn round again*). A genus of *Compositæ*, found in the Mediterranean region, and bearing considerable resemblance to the chamomile. *A. Pyrethrum* is the pellitory of Spain, and is cultivated for the sake of its pungent roots, which are used in medicine.

Anadyomene (Gr. ἀναδυομένη). An epithet applied to the goddess Aphrodite, in reference to the myth that she rose from the sea. (Hesiod, *Theog.* 191.)

Anæsthesia (Gr. ἀναισθησία, from ἀ, *not*, and αἴσθησις, *sensation*). In Medicine, diminution or loss of the sense of touch.

Anæsthetics (Gr. ἀ, *without*, and αἰσθάνομαι, *I feel*). Substances which produce insensibility, apparently by suspending certain of the functions of the nervous system: among these, the vapour of ether and of chloroform are the most manageable, and have lately attracted much notice in reference to the performance of surgical operations under their influence. [ETHER; CHLOROFORM.]

Anaglyphic. Embossed work, in opposition to diaglyphic, or sunk work: the small cameos are good illustrations of the anaglyphic process of effecting a work of art.

Anaglyphy. Sculpture executed in high relief; this word is synonymous with *alto-relievo* when applied in works upon Architecture.

Anaglyptograph (Gr. ἀνάγλυπτος, *wrought in low relief*, and γράφω, *to engrave*). An instrument invented by Mr. Bate, by which a correct engraving of any embossed object, such as a medal or cameo, can be executed. A point is passed over the medal at an angle of 45°, communicating a motion to a diamond point. As the point passing over the medal is raised or depressed, the diamond point takes a corresponding curve, so that the lines ruled on the plate form certain curves, the effect of which is to give a correct drawing of the medal. (Smee, *Electro-Metallurgy*.)

Anagnostes (Gr.). A domestic servant employed by wealthy Romans to read to them

at their meals and on other occasions. The ancient monks and clergy preserved the same custom, and name.

Anagram (Gr. ἀναγράμμα, *a transposition of letters*). The most proper, and most difficult, species of anagram is that which is formed by the reading of the letters of a word or words backwards: as 'evil,' 'live.'

Live, vile, and evil, have the self-same letters;
He lives but vile, whom evil holds in fetters.

A less perfect anagram is that which is made by transposition of letters *ad libitum*: and an anagram in which the transposition is helped out by the admission of letters not in the original word, or the rejection of some of those which it contains, is termed impure. The manufacture of anagrams, particularly out of proper names, formed a favourite exercise of ingenuity in the 16th and 17th centuries; when a common mode of flattery was by inventing some complimentary transposition of the letters of the name of the person addressed. But none of the anagrams of that period exceed, in felicity, Dr. Burney's on Lord Nelson: 'Horatio Nelson,' 'Honor est a Nilo.'

Anal. In Ichthyology, the fin which is placed between the vent and tail, and expands perpendicularly.

Anal Glands. In Comparative Anatomy, organs for secreting substances, sometimes attractive, but generally repulsive in their properties, and applied to purposes of defence; they present every grade of the glandular structure, from the simple cæcum, or tube, to the conglomerate mass; developed from, and consequently always opening into, the termination of the intestine, near the anus. In insects, the sweet fluid ejected by the aphides, and of which the ants are fond, is, at least in some species, the product of secerning tubules opening near the anus. Odorous substances — sometimes fragrant, sometimes fetid — are in different species of insects respectively emitted from the same part; and the singular defensive acrid vapours discharged explosively by the insects called 'bombardiers' are the products of anal glands. In the mollusks, the most remarkable example of the anal glands is presented by the higher organised cephalopods, where they are represented generally by a single, sometimes by a bilobed or trilobed, cyst, with part of its parietes spongy and glandular, and which secretes the inky fluid which these animals eject to blacken the water around them for the purpose of concealment in time of danger. Among fishes, an anal bag opens by a single narrow duct, as in cephalopods, into the termination of the rectum, in rays and sharks; but it no longer exercises the function of a secerner of colouring matter. In reptiles, the anal bags are either single, double, or triple; and in many species, as in frogs and tortoises, are developed to a great size, and serve for aquatic respiration. In crocodiles they are two in number, and emit into the cloaca a muco-caseous secretion, without any stronger odour. In birds the anal follicles have a similar function, but they are aggregated into a single cavity, which is called the 'bursa Fabricii.' In quadrupeds, the anal follicles are generally collected into two sacciform groups, each having an opening near the verge of the anus. The insupportably disgusting odour of the secretion of these glands has rendered some of the viverrine quadrupeds, as the skunk, &c., proverbial; in others, the odour is not stronger than serves to attract the individuals of the same species to one another, and this is the common function of the anal glands in this class of animals.

Anal Valves. A mechanical structure for defending the terminal orifice of the intestines in some of the Cephalopoda, which swim forwards, from the retrograde entrance of foreign or noxious substances. This mechanism is required from the position and direction of the anal opening, which is turned forwards towards the base of the funnel or respiratory channel.

Analcime (Gr. ἀναλκις, *weak*, in reference to its weak electric power when heated or rubbed). A hydrated silicate of soda and alumina, generally occurring in icositetrahedral or twenty-four-sided crystals, which are either colourless and transparent, or white, grey, red, and opaque. It is usually found in the cavities of amygdaloidal rocks, and is common in the trap rocks of Ireland and Scotland. The most perfectly pellucid crystals are met with in the dolerite of the Cyclopean Isles near Catania in Sicily, and in the Tyrol.

Analecta (Gr. *things selected*). In Literature a collection of short pieces, extracts, &c., is termed 'Analecta' (plural).

Analemma (Gr.). In Geometry, the projection of a sphere upon the plane of a meridian, the eye being supposed to be placed at an infinitely distant point of the radius perpendicular to that plane. In this projection, which is also called *orthographic*, all small circles whose planes are parallel to that of projection are represented by concentric circles of the same magnitude as the originals, all circles in planes perpendicular to that of projection are seen as chords or diameters of the meridian circle, and, lastly, all other circles of the sphere are projected into ellipses. [Projection of the Sphere.]

The word analemma also denotes an instrument by means of which some of the common astronomical problems may be solved, though not very exactly. It consists, essentially, of a plane of brass or wood, on which the projection is made, and is provided with a moveable horizon.

Ptolemy wrote a treatise on the analemma, of which there is a Latin translation from an Arabic version, with a commentary by Commandine. Since the invention of trigonometry, however, contrivances of this kind have become almost useless.

Analepsy (Gr. ἀναλαμβάνω, *I recover*). A species of epileptic attack of sudden and frequent recurrence; but not considered dangerous.

Analogue (Gr. ἀνάλογος, *according to rule*

or proportion). A body that resembles another. A fossil shell of the same species as a recent one is its analogue. In Comparative Anatomy, an organ which resembles another in its functional relations, as the wing of a bird, is analogous to the wing of the flying lizard (*Draco volans*) and to the wing of an insect, though it be not in its structural relations the corresponding organ of the body.

Analogy (Gr. ἀναλογία, *the proportion of ratios*). In ordinary language, denotes a relation or similarity between different things in certain respects. The conclusions to which we are led concerning one thing, by reasoning from our experience concerning another similar thing, form what is termed analogical knowledge. The word analogy is generally employed to designate an imperfect degree of similarity. Thus, a physician, arguing from the effects which he had seen produced by a drug on one man, to its probable effects on another man, would be said to reason from experience: but reasoning from the effects produced on an inferior animal, to the probable effects on man, would be, more properly, reasoning by analogy. Thus also Bishop Butler, in his celebrated treatise on the *Analogy of Religion Natural and Revealed*, has argued, after Origen, that the same sort of difficulties, which are found in the constitution of nature, must be looked for in the spiritual world, and that the existence of this analogy is a proof that Revealed Religion proceeds from God, the Creator of the material universe.

In Rhetoric, the word analogy is employed in a somewhat stricter sense; it designates, not the specific resemblance between two objects, but a resemblance between the relations in which they stand to other objects. Thus, to term youth 'the dawn of life' is said to be a metaphor by analogy; not because of any actual resemblance between youth and morning, but because the one is to life what the other is to the day. Thus also a hat is analogous to a turban, and both are analogous to a bonnet, having a similar relation to the head of the wearer. In this sense, a porpoise is analogous not only to a fish, but to every other animal which habitually moves and seeks its food in the water. But it often happens that a similarity of relationship to a medium of locomotion, a kind of food, &c., is accompanied with a certain amount of corporeal and organic resemblance; and this constitutes a kind of analogy, though by no means in the strictly logical application of the word.

In Grammar, analogy means a conformity in the principles of organisation of different words or collections of words.

In Geometry, analogy signifies the same thing as proportion, or the equality or similitude of ratios. [PROPORTION; RATIO.]

In Zoology the term analogy is usually restricted to the relation which animals bear to one another in the similarity of a smaller proportion of their organisation; thus the *Ascalaphus italicus*, in the length and knobbed extremities of its antennæ, the colouring of its wings, and its general aspect, exhibits a striking resemblance to a butterfly; but in all the essential parts of its organisation it adheres to the neuropterous type of structure: its relation to the Lepidoptera is therefore said to be one of analogy, while it is connected to the ant-lions by the order of affinity. As it has been found in some instances that two series of animals, arranged according to the greater amount of resemblances, or the relation of affinity, are connected to one another by analogical resemblances at given points of the series, the relation of analogy has been regarded as differing from that of affinity not only in degree, but in kind. If a zoologist, for example, were led, by a too superficial glance at the external resemblances of two animals, to place them in the same series contiguous to one another, and it were discovered that the resemblance was but skin-deep, or limited to a temporary state of being, as a stage of metamorphosis, but contradicted by a dissimilarity of a greater proportion of the internal organisation, then it would be said that he had mistaken a relation of analogy for one of affinity; a phrase which the reader, however, will readily perceive merely expresses the fact that a false judgment had been formed, from not taking into consideration the whole of the points of comparison necessary for determining the mutual relation of animals to each other.

Analysis (Gr. ἀνάλυσις, from ἀναλύω, *I resolve*). A Greek word, which signifies the resolution of a thing into its component parts. In Logic, analysis is used in opposition to synthesis, as a method of arriving at adequate definitions. In the synthetical method, we begin by assuming some quality which the subject is known to possess. Finding this to be common to other subjects than the one we wish to define, we add some further property, and so on, until we have adequately distinguished it from all other things. Thus man is an animal, man is a hot-blooded animal, man is a hot-blooded viviparous animal, &c. &c., may be taken as a specimen of a synthetical process. In analysis we should reverse the method: assuming the most distinguishing characteristic, and descending, through successive gradations, to that which is least so. Correspondently with this distinction, an analytical proposition is one in which the subject is implied in the predicate: e.g. 'matter is extended.' A synthetical proposition, on the contrary, is that in which the terms have no necessary connection: e.g. 'John is tall;' 'the world is round.' As applied to mental phenomena, analysis is the referring them to the acts or faculties of the mind which they necessarily imply, either as contemporaneously contributing to their production, or as rendering their production possible by their past operation. [*Infra*, ANALYSIS, in Geometry.]

The distinction frequently made between analytic and synthetic reasoning rests on a somewhat vague use of language. Strictly speaking, all reasoning can be but of one kind.

A process of ratiocination admits, however, of being reversed: i.e., we may make certain assumptions, and from them form certain legitimate deductions; and we may then proceed to take the truths thus deduced for granted, and by a counter-process arrive, as inferences, at what, in the former case, were the grounds from which we started. Here it is evident that the distinction lies not in the reasoning, but in the subject-matter concerning which we reason.

Analysis. In Chemistry, this term is applied to the resolution of compound bodies into their elements. It is either *qualitative* or *quantitative*. Qualitative analysis consists in the determination of the component parts merely as respects their nature, and without reference to their relative proportions: it is an imperfect, and often a very easy operation, as compared with quantitative analysis, by which we determine not merely the components of a compound, but their relative proportions: to effect this, much scientific skill and practical dexterity are required, more especially in the identification of new substances. The theory of definite proportionals, or the Atomic Theory, as it is usually called, has materially facilitated many analytical processes, and is especially valuable as furnishing an unerring test or criterion of the general accuracy of the results.

In reference to chemical analysis generally, but more especially as regards organic products, we often employ the terms *proximate* and *ultimate* analysis; the former referring to the immediate combinations which form the subject of experiment; the latter, to their final resolution into elementary principles. Thus, in regard to sulphate of lime, it is resolved by proximate analysis into sulphuric acid and lime, and these are called its proximate elements: but sulphuric acid is itself a compound of oxygen and sulphur; and lime, of oxygen and calcium; oxygen, sulphur, and calcium, therefore, are the results of the ultimate analysis of sulphate of lime; and there are many theoretical points in chemistry dependent upon the views which are taken of the various groupings of these ultimate principles. Wheat flour is a compound of starch and gluten; starch is compounded of oxygen, hydrogen, and carbon; and gluten, of the same elements with the addition of nitrogen; so that the ultimate components of wheat are oxygen, hydrogen, carbon, and nitrogen.

Analysis. In Geometry, a method of conducting geometrical inquiries, invented by the philosophers of the school of Plato, or, according to Theon of Alexandria, by Plato himself, and one of the most ingenious and beautiful contrivances in the Mathematics.

'Analysis,' says Pappus, 'may be distinguished into two kinds: in the first, which may be called contemplative analysis, we propose to discover the truth or falsehood of an affirmed proposition; the other belongs to the solution of problems, or the investigation of unknown truths. In the first we assume the subject of the proposition advanced to be true, and proceed through the consequences of the hypothesis till we arrive at something known. If this result is true, the proposition is true also, and the direct demonstration is obtained by stating in an inverse order the different parts of the analysis. If the ultimate consequence at which we arrive is false, the proposition was also false. In the case of a problem, we first suppose it to be resolved, and deduce the consequences resulting from that solution till we arrive at something known. If the last consequence involves only something which can be executed, or is comprised among what geometers called *data*, the proposed problem can be solved; and the demonstration, or rather in this case the construction, is obtained, as in the former case, by taking the different parts of the analysis in an inverse order. If the last result is impossible, the thing demanded is also impossible.'

The names of the ancient writers on the geometrical analysis have been preserved by Pappus in the preface before referred to: they are, Euclid, in his *Data and Porismata*; Apollonius, in his treatise *De Sectione Rationis*, and in his *Conic Sections*; Aristæus, *De Locis Solidis*; and Eratosthenes, *De Mediis Proportionalibus*: but of these only the *Data* of Euclid, and some fragments of Apollonius, have come down to our times. The subject has, however, been fully investigated by modern authors, and a complete system of the ancient geometrical analysis may be found in the works of Dr. Simson of Glasgow. [See also Leslie's *Geometrical Analysis*.]

Accordingly analysis is directly opposed to synthesis, which advances step by step through known propositions, from the data to the quæsita in the case of a problem, or from the hypothesis to the predicate in the case of a theorem. Analysis is the chief, though not the sole instrument of discovery, whilst synthesis adapts itself naturally to instruction. Euclid's *direct* demonstrations, for example, are all synthetical; his *indirect* ones, however, retain the analytical character. The methods of conducting analysis and synthesis are the same in kind, the only difference being that, in the hands of the investigator at least, the several steps of the former are experiments suggested by experience, for which no rule can be assigned, whereas in the latter these steps are suggested by previous knowledge gained, in fact, very frequently from a preliminary analysis.

The ancient geometers conducted their analysis by means of ordinary language solely; their successors, on the other hand, very frequently availed themselves thereby of the powerful resources of algebra. As a consequence of this habit the word analysis, until a very recent reaction set in, lost entirely its original meaning as a *method* of reasoning opposed to synthesis, and by a strange perversion of terms became synonymous with algebra and the calculus; that is to say, with the *instruments* employed in investigation. The fact that algebra may be, and often is, employed synthe-

tically as well as analytically appears to have been overlooked.

Analysis of Light or **Spectrum Analysis**. [SPECTRUM ANALYSIS.]

Analytical Geometry. See *Coordinate Geometry*, by which name this application of algebra to geometry is more appropriately designated.

Anamirta. A genus of *Menispermaceæ*, yielding the fruits known as *Cocculus indicus*, imported from India, and said to be extensively used in the adulteration of beer, the intoxicating power of which is increased by means of an acrid irritant poison which they contain. The plant from which these fruits are obtained, *A. cocculus*, is a climbing shrub, and is found in the Indian Islands, Malabar, and Ceylon. The fruits are occasionally used externally to destroy vermin.

Anamirtic Acid. The acid of a neutral fat contained in *Cocculus indicus* or the seeds of the *Anamirta*. It is probably stearic acid.

Anamirtin. The neutral fat of Anamirta or *Cocculus indicus* seeds. It is probably stearine.

Anamorphosis (Gr.). In Natural History, expresses the change of form which may be traced throughout the species or higher members of a natural group of animals or plants, either in the actual series, or, as they have succeeded each other in the course of time on this planet; which change is usually ascensive, or indicative of a progression towards a higher series of species. It has been conjectured that the succeeding or supplanting species may be actually the species supplanted, but changed, i.e. otherwise and commonly more highly developed, but of this there is no proof; and the term 'anamorphosis' must be understood as expressive of an *ideal* change, in contradistinction to the real or bodily change, called 'metamorphosis,' observed in the developement of the individual.

ANAMORPHOSIS. In Botany, when any part assumes an appearance unusual with it. The calyx of the rose assuming the appearance of a fruit, the stipule of a *Prosopis* become spiny, and the stem of a cactus when succulent and leaf-like, are cases of anamorphosis.

ANAMORPHOSIS. A term employed in Perspective, to denote a drawing executed in such a manner that, when viewed in the common way, it presents a confused or distorted image of the thing represented, or an image of something entirely different; but when viewed from a particular point, or as reflected by a curved mirror, or through a polyhedron, it recovers its proportions, and presents a distinct representation of the object.

Ananas, or **Ananassa** (Brazilian, *ananas*). The plant that produces the pineapple, *Ananassa sativa* or *Ananas sativus*. It is of South American origin, but has been gradually dispersed through similar climates till it has become apparently wild in parts of Africa and Asia, especially the Malayan Archipelago, where it arrives at a greater degree of excellence than in its native woods.

Anandrous (Gr. ἄνανδρος, from ἀ, priv., and ἀνήρ (genitive ἀνδρός), *a male or stamen*). When flowers are destitute of stamens, such flowers are more usually called female flowers.

Anapæst (Gr. ἀνάπαιστος). A foot in Greek and Latin metre, consisting of two short syllables followed by a long syllable.

Anaphora (Gr.). In Rhetoric, a repetition of words or phrases at the commencement of sentences or verses. Thus in Cicero, *Verr.* iv. c. 10, *Verres calumniatores apponebat, Verres adesse jubebat, Verres cognoscebat, Verres judicabat.*

Anapophysis (Gr. ἀνά, *backward*; ἀπόφυσις *an offshoot*). That process of a vertebra which, arising in the dorsal region from above the diapophysis or transverse process, recedes to the side of the centrum, as the vertebræ approach the sacrum, and projects more or less backwards. It usually supports and strengthens the joint of the anterior zygapophysis of the succeeding vertebra. It is well developed in the hare and most Rodents.

Anarrhichas. A name conceived by Gesner, and applied by Linnæus to a genus of spiny-finned osseous fishes, characterised by having their mandibular, palatine, and vomerine bones armed with large osseous tubercles, bearing on their summits small enamelled teeth. Anteriorly the jaws support longer and more conical teeth. By means of this powerful dental apparatus the species of this genus which inhabits the northern seas, called the 'wolf-fish,' is enabled to break and bruise the testaceous defensive coverings of shellfish, the soft parts of which form its ordinary food.

Anas (Lat. *a duck*). The name of a Linnæan genus of Anserine birds, characterised by a large, broad, obtuse bill, furnished at the margin with numerous thin, transverse, projecting plates, and an obtuse papillose or ciliate tongue. The subdivisions of this extensive group of web-footed birds, which were indicated by Linnæus, have since been raised to the rank of genera [ANATIDÆ], and the term Anas is now restricted to the species which present a flattened bill, the base of which is always of greater breadth than depth, as wide (or wider) at the extremity as at the beginning; with nostrils placed nearer the upper margin and base of the bill. The legs are shorter and placed farther back than in the geese (*Anser*); they have a shorter neck, and the windpipe is dilated at its lower end into two osseous capsules, of which the left is usually the larger. The ducks, thus characterised, are subdivided into those which have the hind toe provided with a membrane, and those in which it is naked. Both divisions are again broken up into numerous minor groups, which are distinguished by generic terms.

Anasarca (Gr. ἀνά, *through*, and σάρξ, *flesh*). A diffusion of water through the cellular membrane of the limbs, as in dropsy.

Anastatica (Gr. ἀνάστασις, *resurrection*). A cruciferous herb called the Rose of Jericho, and by botanists *A. Hierochuntina*. It occurs

in the arid wastes of the extra-European Mediterranean region, and has remarkable hygroscopic properties, in which its interest resides. When growing it is an insignificant little herb, with white flowers; but as it ripens under the influence of drought, it rolls up into a ball, and becomes detached from the soil, and is then carried about by the wind until it meets with moisture, when it unrols into its natural form. The plant retains this property of expanding when moistened and curling up when dry for many years.

Anastatic Printing (Gr. ἀνάστασις, *a setting up*). A process by which all kinds of printing or engravings may be transferred to metal, from which impressions can be taken exactly resembling the original. The printed sheet of paper is moistened with dilute phosphoric acid, and subjected to great pressure upon a zinc plate. The plate is washed with an acid solution of gum, and then inked; the chemical affinities in some instances, and the repulsions in others, causing the lines of the device only to take the ink. The plate is then printed by the ordinary lithographic press.

Anastomosis (Gr.). The communications of vessels with each other.

Anastrophe (Gr. from ἀναστρέφω, *to invert*). A name given in Classical Philology to some species of inversion [INVERSION] or departure from the usual order of succession in words. Such phrases as mecum, vobiscum, &c., in which the preposition follows the word governed by it, or in which it is placed between two words governed by it, &c., are instances of anastrophe.

Anatase (Gr. ἀνάτασις, *extension*). A mineralogical name for titanic acid or *oxide of titanium*, having reference to the height of the pyramids of the octahedral crystals in which it occurs. These are small, of various shades of brown, passing into indigo-blue, and of a greenish-yellow colour by transmitted light; semi-transparent to opaque; lustre splendent and adamantine. It is found in Cornwall at Looe Mills Hill Quarry near Liskeard; in Devonshire at the Virtuous Lady Mine near Tavistock; in N. Wales at Tremadoc; also in Dauphiny, Spain, the Tyrol, Norway, the Ural, &c. The detached crystals from Brazil resemble diamonds so much in colour, brilliancy and general appearance, as sometimes to be mistaken for them.

Anathema (Gr. ἀνάθεμα). Properly, a thing laid by, consecrated, or devoted: hence a person upon whom the ban of the church is laid, is said to be anathematised, or in the Jewish phrase, to be 'anathema.' St. Paul says, 'If we or an angel from heaven preach any other gospel to you than that which we have preached, let him be anathema:' and upon the authority of this and similar passages, the church assumed from the first the power of anathematising or excommunicating evildoers and heretics.

Anatidae. The name of a family of web-footed birds, of the swan, goose, and duck kind, of which the genus Anas is the type.

Anatomy (Gr. ἀνατομή, from ἀνά, and τέμνω, *I cut*). This term literally means *dissection*, but is generally understood to signify a knowledge of the internal structure of the human body, in the acquisition of which dissection is essentially necessary. The anatomy of other animals is usually designated Comparative Anatomy; and that of plants, Vegetable Anatomy (which see).

Although some anatomical knowledge must have been accidentally acquired by the earliest inhabitants of the globe, and although there are several allusions in the early books of the Old Testament to the subject, no dissections of the human body were performed with a view to ascertain the position and structure of its internal organs, or to elucidate their functions, till a much later period.

Homer has, it is true, been complimented, and in some respects justly so, for the precision with which he describes the wounds of his heroes; and the ancient Egyptians are said to have acquired great anatomical skill by their practice in the art of embalming; but these, and similar statements, have no bearing upon the pursuit of anatomy as a science, or in connection with surgery, medicine, and physiology. Thales, Socrates, Xenophon, and Plato, are each quoted by anatomical historians, as having acquired no inconsiderable anatomical knowledge: Plato is even said to have anticipated the celebrated discovery of the circulation of the blood. 'The heart,' he says, 'is the centre of the blood-vessels, the spring of the blood, whence it flows rapidly round: blood is the pabulum of the flesh, for the nutriment of which the body is intersected by canals, like those of gardens, to convey the blood like water from a fountain to the remote parts.'

The first author who is supposed to have written on human anatomy is Hippocrates; and the first recorded dissection was, probably, made by his contemporary Democritus of Abdera. This carries us back to about 400 years before the Christian era, from which period to that of Galen (that is, in the space of 600 years) little progress seems to have been made in the knowledge even of the structure and position of the viscera of the body, much less in their uses and diseases.

It would appear from Galen that the most eminent anatomists of antiquity were Erasistratus and Herophilus, who taught anatomy in the celebrated school of Alexandria, and are said to have been the first who were authorised to dissect human bodies: hence, probably, the high rank which the school, founded by the Ptolemies, acquired, and maintained for several hundred years. The works of the above-mentioned anatomical professors have been lost, but they are abundantly quoted by their more immediate successors.

Among the Romans the first anatomist was, probably, Asclepiades, who flourished in the time of Pompey; and soon afterwards Rome became a celebrated seat of medical science. Celsus, Aretæus, and Galen are the ornaments

of this period; especially the latter, as an anatomist; though it appears probable that his descriptions were often taken from dissections of inferior animals, and applied to the corresponding organs of the human body. It is, however, said, that he anticipated many subsequent discoveries, and that a great part of his writings were for a long time unintelligible, till cleared up and explained by the labours of his successors.

During the dark ages anatomy sustained the fate of other branches of knowledge; and, with few exceptions, little progress was made in it till the revival of learning in Europe. The prejudice, too, against the dissection of the human body was not only maintained, but sanctioned by the highest existing authorities. In the year 1315, a System of Anatomy was drawn up by Mundinus, chiefly, it is said, founded upon such parts of Galen's doctrines as had been preserved by the Arabians. This work deserves notice, as having been the anatomical text-book of the schools of Italy for a period of nearly 200 years. Mundinus is, indeed, celebrated by his contemporaries as the restorer of anatomy. Early in the fifteenth century, when learning began to revive in Europe, in consequence chiefly of the introduction of the writings of the Greek authors, numerous treatises on the Sciences made their appearance, amongst which anatomy formed a prominent subject; and among its most successful followers, the name of the celebrated Leonardo da Vinci may be recorded, although he apparently only pursued it in reference to his own art. [See the sketches annexed to *Memorie Storiche di L. da Vinci*, by C. Amoretti, Milano, 1804.] In reference to some of the drawings and their descriptions, preserved in the library of George III., and to which he had access, Dr. Hunter observes, that he saw with astonishment that Leonardo had been a deep student, 'and was at that time the best anatomist in the world.' We must give the fifteenth century the credit of Leonardo's anatomical studies, as he was fifty-five years of age at its close. At the beginning of the sixteenth century Berengarius and Massa wrote upon human anatomy; but such was the authority of Galen, even at that time, that few dared publish any statement or opinions contradicting those of the infallible master. About the middle, however, of the sixteenth century, this spell was broken by the celebrated Vesalius of Brussels, who taught anatomy at Paris and Louvain, and afterwards in Italy. He boldly demonstrated the errors of Galen; described accurately the dissections of the body, corrected and improved anatomical nomenclature, and insisted upon the necessity of diligence and actual observation in dissection, as the only solid foundation of successful medical and surgical practice. He had many opponents, and is said to have been detected in the very mischievous error for which he blames Galen; namely, that of describing the human viscera from dissections made upon quadrupeds.

Among the most remarkable contemporaries or immediate successors of Vesalius, were Fallopius and Eustachius—the former of Padua, the latter of Venice; whose names, as annexed to their discoveries, have been handed down to posterity. Indeed, the schools of Italy seem to have been the only accessible sources of practical anatomy at that period: in France and England an antipathy to dissection prevailed, which was fatal to all anatomical improvement. Cortesius, who wrote at the beginning of the seventeenth century, and who, after having been professor of anatomy at Bologna, filled the chair of medicine at Massana, complains that he was prevented finishing a treatise on Practical Anatomy, in consequence of having only been able twice to dissect a human body in the course of twenty-four years, 'whereas in the academies of Italy there is that opportunity once every year.'

About this time the name of the renowned Harvey becomes conspicuous in the annals of anatomy: he, like his most eminent contemporaries, studied medicine in Italy. Fabricius ab Aquapendente, who was his master, had just made the highly important discovery of the valves of the veins; and it was this which, probably, more especially directed Harvey's attention to the use of the heart, and the vascular system: for at that time the liver was considered as its great centre, and the veins were supposed to convey the blood from it to the remote parts of the body. Harvey's great discovery of the circulation of the blood was taught by him in his lectures as early as 1616, though not published till 1628, in consequence of his desire to demonstrate the subject in detail, and to collect proofs and illustrations of the correctness of his doctrines. This discovery was not only of vast intrinsic importance, but, as is the case in all similar instances, it led to others; and the route of the blood had no sooner been traced and described, than the manner in which the nutritious part of the food is conveyed into the circulation became an object of research: this was successfully developed by Asellius, an Italian physician, in the year 1627. He was so fortunate as to see the lacteals filled with chyle, and to trace them to their common trunk, the thoracic duct, and thence into the blood-vessels. The lymphatic system was also soon afterwards detected, and first described by T. Bartoline, a Danish anatomist; and this was followed by important details bearing upon the anatomy of the gravid uterus and of the generative system, in which nearly all the celebrated anatomists of Europe had a share; and among them Harvey was conspicuous, though Dr. Hunter attributes, with apparent injustice, his knowledge upon this subject, and even the merit of detecting the use of the arteries, to his master Fabricius. The physiology of generation was more especially followed up by Swammerdam, Malpighi, and Leuwenhoeck, who were enabled greatly to extend the bounds of anatomical knowledge by their ingenious use of the microscope.

Although this country has produced many celebrated anatomists, there is no one to whom we are so deeply indebted as Dr. William Hunter, who was born in 1718, at Kilbride, in Lanarkshire, and was contemporary with the celebrated Cullen. Dr. Hunter came to London in 1741, bringing with him an introduction to Dr. Douglas, who was then engaged in a work upon the bones, and was in search of a young man who might assist in his dissections. He found in William Hunter a person so exactly suited to his purpose, that he not only engaged him as an assistant, but received him into his family and made him his son's tutor. As our object here is to give a brief historical Outline of Anatomy, rather than the biography of its successful cultivators, we must pass over many interesting points in Dr. Hunter's early history, till he came before the public as an anatomist in the year 1743, when he communicated to the Royal Society an essay *On the Structure and Diseases of Articulating Cartilages*, and was remarked for his diligence, ingenuity, and skill in the arrangement of anatomical preparations, of which he had accumulated a considerable collection, with a view of pursuing his favourite object, namely, that of publicly teaching anatomy. He commenced this arduous task in 1746, under the auspices of Mr. Sharpe, of Covent Garden, in whose theatre he made his first appearance as a public lecturer. In 1747 he became a member of the Corporation of Surgeons; and in the spring of the following year, having concluded his course of lectures, he accompanied his pupil, Mr. James Douglas, into Holland and France. He returned in time to begin his winter course, during which he not only acquired a high character as an anatomist, but commenced the practice of midwifery, in which he soon attained eminence, founded not merely upon his person and address, both of which were agreeable and well suited to that line of the profession, but upon his anatomical skill; so that in all cases of danger and difficulty it soon became customary to call in his aid. In this respect his celebrity became so extended, that he afterwards acquired great and merited reputation as a general anatomical physician. In 1762 Dr. Hunter entered into a spirited vindication of his claims to certain anatomical discoveries in a work entitled *Medical Commentaries*; and in the same year he was appointed physician to the queen of George III. His professional avocations now became so numerous and urgent, that he was obliged to take a partner in his lectures, and for that purpose selected his pupil, William Hewson, who afterwards joined Mr. Cruickshank, two gentlemen whose names occupy no unimportant place in the history of practical and structural anatomy.

In 1754 Dr. Hunter began his great and splendid work on the *Anatomy of the Gravid Uterus*, which was not completed till 1775. This gave him a high rank among European anatomists, and foreign and domestic honours were abundantly conferred upon him in consequence; but it is to the establishment of his Museum and School, that we are principally to look for the new impulse which was given to the study of anatomy in London, and for the celebrity which this metropolis has since maintained. The account of the origin and progress of this Museum, therefore, deserves to be briefly recorded here. When Dr. Hunter had acquired a competent fortune, the result entirely of his high professional merit and unwearied diligence, he found wealth still pouring in upon him, and became desirous of applying this surplus to some great national purpose of public utility; and what more important or useful than 'A Metropolitan School of Anatomy?' He accordingly, in the year 1765, during the administration of Mr. Grenville, presented a memorial to that minister, in which he requested the grant of an unemployed piece of ground near the King's Mews, at Charing Cross, for the site of his intended building; upon which he undertook to expend 7000*l.*, and to endow a professorship of anatomy in perpetuity. After waiting for some time without a reply, he renewed his request, or rather repeated his proposal; and his second application, which was even in more liberal terms than the former, shared the same supercilious treatment. Although disgusted, as he well might be, at this unaccountable neglect, he determined that the town in which he had acquired his wealth and reputation should not be without some useful and honourable memorial of his labours: he accordingly purchased a piece of ground in Great Windmill Street, near the Haymarket, where he erected a spacious dwelling-house, behind which was a magnificent fire-proof room, fitted up as a museum and library, and communicating with a good anatomical theatre, and an extensive series of apartments for dissection and for the preparation of anatomical specimens. This building was completed in 1770.

Dr. Hunter expended upon this Museum a sum exceeding 20,000*l.*: it included, besides its unrivalled anatomical treasures, a splendid and valuable collection of books, coins, medals, and antiquities; of minerals, shells, and other articles of natural history. By his will, the use of this Museum, under the direction of trustees, devolved upon his nephew, Dr. Matthew Baillie; and in case of his death, to Mr. Cruickshank, for the term of thirty years; at the end of which period the entire collection was bequeathed to the University of Glasgow, together with a sum of 8,000*l.* for its preservation. Dr. Hunter died on March 20, 1783; so that his will, in regard to his Museum, has long since been carried into effect, and it is now in Glasgow. To say nothing of the books, antiquities, and objects of natural history, it contained, when sent to its final destination, the finest series of anatomical specimens in Europe. Thus, through the apathy of the administration of that day, was this unrivalled collection lost to the English metropolis. Dr. Hunter's munificent intentions must, however,

never be forgotten: he furnishes a noble and rare example of a man who, as soon as he had rendered himself independent by his own exertion, in a laborious and difficult profession, applied the whole of his large income to a great public object; and, though thwarted in his original desire, that it should remain in the metropolis in which the fortune expended upon it had been amassed, as a monument of his gratitude and an example to his successors, he was, nevertheless, sufficiently liberal and patriotic to devote it to the use of the public, by bequeathing it to the university which had granted him his degree.

Dr. Hunter not only gave a new impulse to anatomical science, the effects of which have been transmitted to the present time, but his zeal in behalf of his favourite pursuit tended to make many converts. Among these, the celebrated John Hunter stands foremost. Hearing of his brother's reputation, he offered his services as an assistant in his inquiries, and his proposal was kindly accepted. Accordingly, in September 1748, he left Lanarkshire, being then twenty years of age. His disposition to excel in anatomical pursuits soon became evident. In the course of the succeeding year he had rendered himself sufficiently master of the subject to instruct his brother's pupils in the dissecting-room; and in 1755 was admitted to a partnership in the lectures. His ardour and enthusiasm as an anatomist were most extraordinary, and he became as eminent in surgery as his brother was in physic: yet his more lucrative professional avocations were never allowed to supersede his scientific zeal; and the result was, the formation of a Museum of Comparative Anatomy, which is at once a memorial of a scientific mind and a skilful hand. Mr. Hunter died suddenly on October 16, 1793, at the age of 65. He directed by his will that his Museum, upon which he had expended nearly the whole of his large professional income, should be offered to the purchase of Government; and, fortunately for the credit of our country, the proposal met with a very different reception to that which we have above recorded in reference to his brother. It was purchased for the sum of 15,000*l.*, and made over, under certain conditions, which have been not only faithfully, but liberally, fulfilled, to the Royal College of Surgeons, in London. It is one of the most splendid collections in the world, and in many respects unrivalled; it is open, under proper regulations, to public inspection, in the magnificent building erected by the College for its reception, on the south side of Lincoln's Inn Fields.

Another convert to anatomical pursuits, educated in the school of William Hunter, was his nephew, the late Matthew Baillie. His virtues and his talents placed him high in public estimation; his anatomical knowledge was the foundation of his professional eminence; and the excellence of his lectures, both as regards matter and manner, tended to exalt the reputation of his uncle's school, and to establish the importance of anatomy as the basis of medical, no less than of surgical practice.

We have dwelt upon the Hunterian School, from the conviction that it gave a character to anatomical pursuits, which has materially and beneficially influenced their subsequent progress, not only in London, but throughout the kingdom. Their importance and their necessity as the basis of the sciences of medicine and surgery are now publicly felt and acknowledged; the aversion to the dissection of the human body is on the wane; and the degrading and disgraceful practice of allowing the schools of anatomy to be supplied with subjects for dissection by the revolting process of exhumation, has been superseded.

Human anatomy is usually subdivided into *descriptive* and *morbid*, or, more correctly, *pathological*.

Descriptive Anatomy embraces a description of the different organs of the body, together with their relative situations and connections; it examines the textures of which they are formed, enumerates the nerves and vessels by which they are supplied, and gives all general and particular details concerning their organisation. Having done this, it proceeds to the analogies that subsist among the materials of which different organs are composed; and is thus led to specify the proximate constituent parts of the living body.

Morbid or *Pathological Anatomy* comprehends all that relates to the effects of disease upon healthy structures; and carefully traces and describes the changes of texture and of composition which they thus suffer, in reference to the entire organ, as well as to its individual parts.

We shall now proceed to give a short description of the parts of which the human body is constructed, referring for the account of individual organs to the separate terms under which they are enumerated.

Anatomical teachers generally first direct the student's attention to that branch of the subject which is termed *Osteology*; in other words, to the bones or skeleton, constituting the hardest and most durable part of the whole structure, and that which gives it its stability and general form. At the period of birth, the bones, for obvious reasons, could not exist with the degree of induration and firmness which they possess in the adult; we accordingly find that, at that period, they are mostly soft and flexible, resembling cartilage, with certain specks of osseous matter, which gradually extend and increase, as the process of ossification advances during the growth of the young animal. In contemplating this bony skeleton when it has thus become perfect, we are struck with the admirable adaptation and mutual connection of the various parts of which it consists; the separate bones being extremely numerous (including the teeth, amounting to about 250), and attached to each other by unequal surfaces, the cavities and eminences of which mutually correspond. These connections, termed *arti-*

culations, are extremely various; some admitting of every variety of motion, others of limited motion, and others, as it were, continuously united. In the former case the evils of friction are perfectly provided against by the peculiarity of the articulating surfaces, which are covered with an extremely smooth and elastic substance, called *cartilage*; and lubricated, or as it were oiled, by a slippery fluid termed *synovia*, which here performs precisely the same office as that of the various anti-attritions which are used in machinery. But as the bones must be more or less restricted in their range of motion, there are peculiar means by which that end is attained: some being prevented from changing their relative situations by certain modes of articulation; others, where a slight motion is required, being united by cartilage; and others, where extensive and varied motions are wanted, being connected by ligaments, membranes, or flesh.—*Ligaments* are white, fibrous, glistening, and flexible substances, occurring in an infinite variety of forms and situations. They are, for the most part, exterior to the joint, and, by their great strength and trifling elasticity, preserve the relative position or connection of the bones in their various movements.—*Membranes* are thin, whitish webs or textures, more flexible and elastic than ligament. They not only assist in the security and motion of joints, but fulfil a variety of other offices. They surround or line the cavities and the organs of the body, and contribute to unite and combine the whole; and, at the same time, interpose, and preserve a distinction, enabling separate parts either to co-operate or to act independently of each other. They vary in strength and texture, and different terms are applied to them in different parts of the body: two within the skull are called *matres*; those which envelope muscular fibres are called *aponeuroses*; that which covers the lungs and lines the cavity of the chest is termed *pleura*; that which lines the cavity of the abdomen and its included viscera is named *peritoneum*; those which inclose articular surfaces are termed *capsules*; that which covers bone, *periosteum*; and, in other cases, they are called *coats*, or *tunics*. The remaining substance concerned in the connection of the bones is *flesh*: it is thus that the upper extremities are connected with the body, and that many of the joints are rendered secure. But flesh performs another and more important office, inasmuch as it constitutes a principal part of the organs termed *muscles*, through the medium of which the various movements of the body are effected. Many of the muscles contain, besides flesh, a substance analogous to ligament, through the medium of which they are attached to the bones, and to which the term *tendon* is applied: muscles and tendons are composed of bundles of fibres, which may be unravelled to extreme minuteness; and when what appears to be a single fibre is viewed under the microscope, it resembles a chain of infinitely small globular particles. But though the muscles are the immediate organs of motion, they are dependent for their powers of contraction and relaxation upon the *nerves* with which they are supplied. These, when separately examined, appear in the form of white cords or threads; and, when traced to their origin, are found to issue as it were from the brain, and from its elongation, termed the *spinal marrow*. The trunks of the nerves are subdivided into branches, and these again into filaments, which enter into, and are, as it were, lost in the substance of the muscles and other organs of the body. Their functions are in some cases obedient to, and in others independent of the will: to the former belong the nerves of the locomotive muscles; to the latter, those of the heart, viscera, &c. When they are divided, the peculiar functions of the organs which they supply are impaired or impeded: thus, the muscles may be deprived of the power of contracting, the glands of secretion, the eye of sight, the ear of hearing, and the skin of feeling. The nervous trunks, which issue in pairs from the brain or spinal marrow, amount to about forty; and in tracing them and their branches, they are found in certain different places to swell into knots, which are termed *gangliæ*, or they are reticularly aggregated into *plexuses*.

Having thus shown how the bones are connected and put into motion, and from what sources their motion is derived, it may next be inquired how they and the other organs of the body grow and are nourished. This brings us to consider the blood and its vessels.

The composition and properties of the blood, and the extraordinary changes which it suffers in its passage through the pulmonary vessels, are elsewhere defined. [BLOOD and RESPIRATION.] Without this exposure to the action of the air in the lungs, the blood is unfit for the support of life. We accordingly find that the heart is so constructed as to propel the blood which it receives through the structure of the lungs, and after it has there been aërated, to transmit it over the body: in fact, the heart is a hollow muscle: when it relaxes, its two principal cavities, or ventricles, are enlarged, and the blood flows in; when it contracts, they are diminished, and the blood is propelled into two large tubes or arteries, one leading to the lungs, and called the pulmonary artery, and the other to the system generally, and called the aorta: these arteries are not only elastic, but also muscular, so that they drive the blood onwards from the heart, its retrograde motion being effectually prevented by valves placed at their origin.

The arteries are divided and subdivided into an infinite number of ramifications; and the branches from the same trunk are frequently observed to unite or anastomose in their course; so that when, by any accident, some are obstructed, an adequate supply of blood may be kept up by the others. As, however, the blood cannot return to the heart

by these vessels or arteries, we find that they inosculate, or communicate at their extremities with another series of tubes or vessels, which are called veins. These are more numerous than the arteries, and generally accompany them in their course. They have less muscular power; and as they are not assisted by the heart in propelling the blood, they open to it larger and larger channels as it advances, and are supplied with valves by which its reflux is prevented. This is, in fact, the circulation of the blood (first made out by Harvey, as before mentioned); the veins ultimately terminating in two large trunks, which pour the blood into the right auricle of the heart, whence it is propelled into the right ventricle, from which arises the pulmonary artery, transmitting it through the lungs. From the lungs the blood (having been aërated) returns by the pulmonary vein into the left auricle of the heart, which contracting, propels it into the left ventricle, from which arises the aorta. Such then is the extraordinary mechanism by which the circulation of the blood is effected; but it must not be supposed that the whole of the blood is thus directly returned from the arterial into the venous system: a part of it is transmitted by minute arterial ramifications into the different structures and organs of which the body is composed, each of which is gifted with the power of assimilation, that is, of converting the blood, or a part of it, into a substance of its own kind. Some of these minute or capillary vessels also terminate upon the surface of the body, where they exhale perspirable matter; others, upon the membranes lining the cavities of the body, where they secrete the fluids which lubricate and moisten the interior surfaces; and others again go to the glands — those peculiar organs or structures, which have not only the power of separating certain parts of the blood, but of converting it into new forms, which are called secretions, some of which are ejected, others retained, for the purposes of the animal economy.

Thus, then, it appears that the blood nourishes and preserves the body and all its parts, and that it is continually tending to the renovation and reproduction of the different organs; but this very process implies another, and no less extraordinary, function, which is performed by a distinct system; namely, that of absorption. There are, in short, a series of vessels which are continually carrying away the useless and worn-out materials; removing them in a state of solution; furnished, like the veins, with valves; terminating in a common trunk, called the thoracic duct; and pouring its contents into the veins, just before they enter the right auricle of the heart.

It appears, therefore, that a continual system of deposition and removal is in action within the living body; that the ramifications of the arterial system are constantly renovating the different organs, whilst the absorbents are as constantly removing the materials of which they consist. Nothing, therefore, is stationary or permanent; and as the blood, on the one hand, conveys the materials required, so, on the other, it receives those which are removed: and such as are useless, or would be hurtful if retained, are thrown off either by the intestines, the kidneys, the lungs, or the skin. It now only remains to show how this waste is compensated, and by what means those materials which are thrown off in one form are replaced in another. This leads us to the functions of another branch of the animal machinery, called the organs of digestion; those organs, namely, by which the food is converted into blood.

Different animals require different kinds and quantities of food; some living almost exclusively upon animal, others upon vegetable substances; hence their division into carnivorous and graminivorous tribes. Man partakes of both; and, accordingly, the structure of his digestive organs is intermediate between the comparative simplicity of the truly carnivorous, and the complexity of the graminivorous classes. In all the higher orders of animals, however, the mechanism of digestion is of a complicated character.

The first change which the food undergoes is in the mouth, where it is torn, ground, and moistened by machinery expressly adapted to those operations. The teeth are admirably contrived for this purpose; some of them cutting, and as it were mincing, others rubbing and grinding, whilst a fluid is supplied by the salivary glands so as to render the mixture of a proper consistency to be swallowed: this is effected by the organs of deglutition. The food is propelled from the mouth into the tube which conveys it to the stomach, and which is called the œsophagus; it is at the same time prevented, by an extraordinary and complicated arrangement of the parts concerned, from passing in any other direction, and more especially from entering the trachea or air-passage into the lungs. In the stomach the food is subjected to the secretions of that organ, called gastric juice, which is acid, and by which it is gradually converted into a greyish homogeneous semi-fluid substance, termed chyme: so that by the time the food has reached the right end of the stomach, or the pylorus, its original characters are entirely changed; its separate materials are no longer discernible, and it has acquired distinct properties; it is, in short, digested. How these changes are effected we know not, though many attempts have been made to explain them upon chemical and mechanical principles. Dr. Hunter, in his Introductory Lecture, has the following apposite remarks, in reference to this and similar phenomena: 'I must therefore expect,' he says, 'that you will not hereafter be surprised, when you find me avowing great ignorance in many of the most considerable questions relating to animal operations, such as sensation, motion, respiration, digestion, generation, &c. In my opinion, all these subjects are much less understood than most people think them. Our vanity deceives us, and persuades us that we

have got the whole as soon as we have acquired a smattering of natural knowledge. Hence it is that the different sects of physiologists have endeavoured to explain animal functions upon such different principles. Hence, for example, to account for digestion, some have made the stomach a mill; some would have it to be a stewing-pot, and some a wort-trough; yet, all the while, one would have thought that it must have been very evident that the stomach was neither a mill, nor a stewing-pot, nor a wort-trough, nor anything but a *stomach*.'

When the food has been thus far digested in the stomach, it passes into the duodenum, or upper end of the intestinal canal; a tube, the whole length of which is about six times that of the body, and which, therefore, is variously and strangely convoluted to enable it to be packed into the abdominal cavity. Into this portion of the intestines various vessels and glands deliver their secretions, partly for the purpose of lubricating its surface, and partly to assist in the further changes which are to be brought about in the chyme. Of these fluids, two are especially remarkable, from the importance and size of the glands by which they are secreted, and of the ducts by which they are conveyed; namely, the *bile*, which is of a green colour and bitter taste, and is secreted in the liver; and the *pancreatic juice*, which appears to resemble saliva, and which is secreted by a gland called the pancreas. The influence of these fluids upon the chyme is direct and important: the pancreatic secretion probably acts as a diluent merely; but the effect of the bile is more complicated; and it appears to be essential to the further change of the chyme into *chyle*, which is a white milk-like fluid, formed in the upper part of the intestine, and absorbed by a distinct set of vessels which, from the colour of their contents, have been called lacteals, and which convey the chyle, that is, the portion of the products of digestion fitted for nutrition, into the above-mentioned trunk of the lymphatics, whence it is transmitted into the veins, which open through the medium of the right auricle into the right ventricle of the heart. The bitter principle of the bile, and its colouring matter, are obviously not absorbed by the lacteals, but remain with the residue of the food, which is slowly propelled along the whole of the intestinal tube, and, having undergone certain changes in its passage, is ultimately voided as excrementitious.

Having now enumerated the various classes of organs in the human body, and adverted to their leading functions; having seen how the bones are united by articulations, and connected by ligaments, flesh, and membranes, forming a variety of levers adapted to the motions of the limbs, and supporting and protecting the soft parts, as in the skull and spine; how the brain and nerves are concerned in the sentient energies, and in presiding over and directing muscular motion, and influencing the functions of the viscera; having likewise seen how each part of the body is nourished by the blood, which is sent from the heart by the arteries, and conveyed back to it by the veins; how the useless and decayed parts are removed by the lymphatics; how the nutritious part of the food is carried into the blood by the lacteals; and how venous is changed into arterial blood in the course of its passage through the pulmonary vessels; it only remains to observe, that the whole fabric is as it were protected from external injuries by its *integuments*. Of these the most exterior is a covering, varying in thickness and induration on different parts of the body, but everywhere without feeling, and called the *epidermis*; immediately beneath it is a soft mucous substance termed *rete mucosum*; and under it the *cutis*, or true skin. These external coverings of the body are attached to and connected with the parts beneath, by cellular membrane. But though the animal owes much of its general security to these textures, it owes more to the senses, instincts, and appetites with which it is so miraculously endowed. 'By these it is led to pursue what is useful, and to guard against danger, inconvenience, and want. Nor is this all; there has likewise been conferred, to a certain extent, upon all living bodies, the power of reproduction, by which they are frequently able to repair the slighter injuries to which the different organs are exposed; and if this power be exceedingly languid in the latter periods of old age, it is because the author of nature never intended that the animal structure should be immortal. He has fixed its bounds, which it cannot pass; and has measured out the time when the fairest fabric must crumble into dust, and its animating spirit return unto Him, the great Almighty Incomprehensible Being, who first bestowed it.' — Dr. Barclay's *Introductory Lectures to a Course of Anatomy*; and see Dr. William Hunter's *Two Introductory Lectures*, for details respecting the history, uses, and importance of the study of Anatomy.

Anatomy, Comparative. So called because the organisation of the lower animals was first principally studied with immediate reference to that of the human subject. Galen, who visited the schools of Alexandria at a period when the dissection of the human body was no longer permitted, sought in the anatomy of the ape to acquire a vicarious knowledge of the anatomy of man. Vesalius, after the revival of literature, dissected various quadrupeds, and compared their organisation with that of man, in order to correct the errors of Galen, and to establish the true knowledge of the peculiarities of the human structure.

Succeeding anatomists have investigated the structure of the lower animals, to acquire the knowledge necessary for experimenting upon them with success; and still more important discoveries in physiological science have resulted from tracing the modification and disappearance of different organs in the descending series of animals, as the only means by which we can obtain just notions of the uses and relative importance of the different organs in the animal economy, and a perception of the laws which

regulate their co-existence in the same individual.

Aristotle, Harvey, and Hunter combined the investigation of the mature animals of different classes with observations of the different stages of developement of the embryo, and their example has been assiduously and successfully followed by the ablest comparative anatomists of the present day, whereby some of the general laws of animal organisation, of developement, and of the analogies which apparently different parts bear to one another throughout the great scheme, have been discovered.

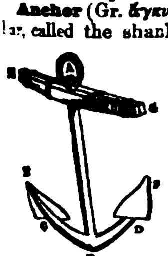
A very important application of comparative anatomy is to the determination of the relative degrees of complexity in the organisation of different animals, and of the number and value of the points of resemblance which different species manifest to each other in the totality of their organisation. A study of the anatomy of animals, guided by these views, is essential to the determination of their natural affinities, which is the highest aim of the philosophic naturalist.

Lastly, the labours of the comparative anatomist continually tend to bring to light examples of structures, designed with reference to special purposes, of the most striking and forcible description; and thus provide for the moralist and divine a storehouse of facts peculiarly adapted to the illustration of the doctrine of final causes. [BIOLOGY; MORPHOLOGY; TELEOLOGY; DEVELOPEMENT.]

Anatropal or Anatropous (Gr. *ἀνατρέπω, I invert*). A very common kind of embryo, produced by one side of the ovule growing upon itself, while the other remains immovable, till at last that part of the ovule which was originally next the apex, is brought down to the hilum, the base of the nucleus in such cases being at the apex of the ovule. The common apple, and the greater part of plants, offer examples of this.

Anauxite (Gr. *ἀναύξητος, without augmentation*). A mineral of a greenish-white colour, which occurs massive and granular at Bilin, in Bohemia. It is composed of silica, with much alumina, a little magnesia and protoxide of iron, and 11·5 per cent. of water.

Anchor (Gr. *ἄγκυρα*). Consists of a straight bar, called the shank, A B, which ends in two arms, B C, B D, on which are placed the triangular plates called flukes, or palms; the extremity E or F is called the pea (peak) or bill; the point B is called the crown. At the end A is placed the stock G H, which, when of wood, consists of two pieces of oak, hooped together. When the stock is of iron, it passes through a hole in the end of the shank. The stock is at right angles to the plane of the flukes, and is a little longer than the shank. At A is the ring, which is of iron, to which the cable is attached, and by which the anchor is lifted or hung.



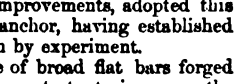
When a hemp cable is used, the ring to which it is bent (fastened in a particular way) is covered first with tarred canvass, and then with pieces of rope secured firmly round it; this is called a puddening, and protects the hemp from the iron. When a chain cable is used, it is shackled to the ring, which is not then puddened.

Men of war and large ships carry two large anchors of equal size, at the bows, called, thence, bower anchors; and two others, of the same size, called the sheet and the spare anchors: besides two or three others, which are much smaller, for temporary occasions.

The anchor, after being let go from the ship's bow or side, whethor the shank be vertical or horizontal when it enters the water, arrives upright at the bottom, in consequence of the resistance of the water on the stock, when it falls over, and rests on the crown, one corner of a fluke, and the end of the stock. From this position of stable equilibrium on three points, forming a long narrow triangle, a small force disturbs it, when the stock, falling flat, one of the bills must pierce the ground, penetrating deeper as the cable pulls, until the arm is partly or entirely buried.

Since the security of the vessel depends on the hold the anchor has of the ground, it is evident that the direction of the fluke should be such that the reaction of the soil against it, from the pull of the cable, may tend most effectually to keep it down.

The pressure on the fluke being perpendicular to the surface, take A B to represent the pull of the cable, then the resolved portion of this perpendicular to the fluke is $BC = AB \cos. ABC$; and the effect of this in keeping the fluke down is $BD = BC \cos. CBD = BC \sin. ABC$, because AB is horizontal, and BD vertical, CBD is $90° - CBA$; hence $BD = AB \sin. ABC \cos. ABC$, which is maximum when $ABC = 45°$. The flukes of anchors in general make the angle with the shank much greater than this; but Lieut. Rodger, R.N., has, among other improvements, adopted this angle in his patent anchor, having established the above conclusion by experiment.



Anchors are made of broad flat bars forged together. As the greatest strain upon the shank takes place during the act of weighing, the diameters of the shank are made unequal, the longest being placed vertical. This improvement is, we believe, due to Mr. Pering, on whose plan anchors have of late years chiefly been made.

The weight of an anchor in men of war is estimated roughly at about 1 cwt. to a gun; in merchantmen, about 1 cwt. for each 15 tons. The weight of the anchor is not strictly proportional to the size of the vessel, as large vessels are less affected by sudden or violent motions than smaller ones are. Large anchors are thicker in

proportion to their length than smaller ones, that is, the weight increases faster than the cubes of the dimensions.

When an anchor is left behind, it is recovered either by lifting it by the buoy rope, or, where that is not possible, by sweeping for it; which is dragging a hawser, hung between two boats, slowly over the bottom till it catches the upper fluke, by which the anchor is then weighed.

When one anchor is down the ship is said to be at single anchor; when two are down, the ship is generally moored. [Moored; Cable; Buoy.] Ships rarely ride by more than two anchors; in bad weather a third is often let go under foot, as a precaution in case of one of the cables parting.

When the anchor is dragged by the pulling of the cable, it is said to come home. When the cable gets twisted round the anchor or stock, the anchor is said to be foul. The anchor is sometimes hove up without one of the flukes, which has either been fixed in a cleft of a rock and wrenched off by the force of weighing, or been snapped off by striking against a point of rock in its rapid descent.

When the ship is at single anchor, the wind or tide may carry her over the anchor; if the water is deep, she may so drag the cable as to foul the anchor, in which case it may not hold again: if the water is very shallow, she may get upon the anchor, the fluke entering the ship's bottom, or she may break the shank by striking upon it. Keeping the ship clear of her anchor is, therefore, an important, as it is also a nice point of seamanship.

When the anchor is lifted out of the ground, it is said to be aweigh; when hove up to the surface of the water, it is awash. The anchor being hove up by the cable only to the hawse holes, is lifted by the ring to the cathead: this is called catting it. The fluke next the ship's side is then lifted up to its resting-place, called the bill board: it is now said to be fished. When the ship is fairly at sea, the ring is lashed close up to the cathead, and the fluke brought close to the ship's side, or inside the bulwark, and the cable and buoy rope unbent: the anchor is then secured.

Anchor. In Architecture, an ornament applied to mouldings somewhat resembling an anchor, intermixed with eggs, and by some called a tongue, from the resemblance it bears to the forked tongue of a serpent. It is found in the mouldings of all the orders, but is only applied to that called the echinus, or quarter round; a singular illustration of it is to be met with in the tower of Layer Marney, in Essex. The term is also applied to the wrought iron ties which are inserted in the cross walls of buildings that have a tendency to separate, the heads of such ties being generally formed by large circular plates; but in the structures of the middle ages they were made in the form of letters, or figures, so as to represent the dates of their insertion. The term anchor is also applied frequently to the portion of a collar used for a lock-gate where it rests entirely in the wall.

Anchorage. Ground fit to hold a ship's anchor, so that she may ride safely. The ground best suited for this purpose is hard sand, or stiff clay; and the best position is that which is land-locked, or out of the tide. The harbour dues paid by ships for casting anchor, are also called *anchorage*.

Anchorite (Gr. ἀναχωρητής, from ἀναχωρέω, *I retreat*, or *withdraw*). More properly, anachoret; a hermit, or person who has retired from the world with the purpose of devoting himself entirely to meditation and prayer. Such was the case with many of the early Christians, beginning, perhaps, with such as fled from the persecutions of Decius and Diocletian. The adoption of perfect solitude was essential to the character of an anchorite: but they were not necessarily bound by vows. The origin of this class of religionists preceded that of the Cœnobites, or monks living in societies; but in later times the monks used frequently to leave their monasteries, with the permission of their superior, and devote themselves for a time, or for their whole lives, to the solitude of anchorites.

Anchovy. [Engraulis.]

Anchusa (Gr. ἄγχουσα). A Boraginaceous genus of Southern Europe and the East, which yields the alkanet, *A. tinctoria*, a dye plant, now sometimes called *Alkanna tinctoria*. The root, which is thick in proportion to the size of the plant, is the part used, and yields a red dye readily extracted by oil and spirits. It is said to be also used for colouring some of the mixtures dignified with the name of port wine.

Anchusic Acid, Anchusine. The red colouring matter of alkanet root. It is soluble in oils and fats.

Anchylosis (Gr. ἀγκύλωσις, from ἄγκος, *a bend* or *hollow*). A stiff, immoveable, or bent joint.

Ancient Demesne. In Law, all lands which, having been in possession of Edward the Confessor, and from him having passed to William the Conqueror, and named in Doomsday Book as Terra Regis, are said to be held in ancient demesne. The tenure is peculiar, resembling copyhold in some respects.

Ancients (Fr. anciens). Gentlemen of the Inns of Court and Chancery. The Inns of Chancery consist of ancients, and students or clerks. The ancients of Gray's Inn are the oldest barristers, and those of the Middle Temple are those who have passed their readings.

Ancients, Council of. In French History, one of the two assemblies composing the legislative body in 1795. It consisted of 250 members, and derived its name from each of them being at least forty years of age. It was put an end to by the revolution of the 18th Brumaire.

Ancile (Lat.). In Roman antiquities, the shield of Mars, which, according to tradition, fell from heaven in the reign of Numa, and was accompanied by an oracle, which declared that,

while it remained in Rome, the city could never be taken. Its figure was that of an oval compressed in the middle. The legend adds that Numa entrusted the care of it to the Salii, or priests of Mars, in whose temple it was placed, and that he had eleven more shields made to exactly the same pattern, in order to prevent the genuine one from being distinguished and stolen. Every year, on March 1st and for many successive days, these ancilia were carried round the city by the Salii, with solemn dances and music.

Ancipital (Lat. anceps, *two-edged*). When anything is compressed, with the two opposite edges thin. It is chiefly applied in Botany to leaves and stems.

Ancistrocladeæ (Gr. ἄγκιστρον, *a hook*, and κλάδος, *a branch*). A natural order of Exogens, containing only the genus *Ancistrocladus*, an Indian climbing plant, of botanical interest only.

Ancona. An old Venetian term used to express a picture, image, or altar-piece; it occurs in old documents, and is a corruption of the Greek εἰκών, an image, picture, or portrait. (Fiorillo, *Geschichte der Zeichnenden Künste*, &c., vol. ii. p. 6, Göttingen, 1801.)

Andalusite. An anhydrous silicate of alumina, named after the province of Andalusia, in Spain, where it was first noticed. It may be distinguished from Felspar by its greater hardness and infusibility. It occurs in slightly rhombic four-sided prisms, sometimes in a compact form with a granular or columnar structure, of a reddish colour passing into pale grey, with a vitreous lustre, and is transparent, or translucent, at the edges. Andalusite is found most frequently in micaceous schist, and in gneiss; less frequently in granite, serpentine, and quartz rock, in Aberdeenshire, Banffshire, the Shetlands, Donegal and Co. Wicklow in Ireland, the Tyrol, Saxony, Moravia, Bavaria, Siberia, Connecticut, Massachusetts, &c.

Andante (Ital. *going*). In Music, is a direction for the time, or rather for the style in which a piece is to be taken. It is moderate, rather slow, but distinct and flowing.

Andes. This magnificent chain, including some of the loftiest mountains of the globe, rises from the shores of the Pacific Ocean, and runs parallel to the South American coast, commencing at Cape Horn and reaching to the Isthmus of Darien. At first, a single narrow range for a distance of 2500 miles, it then for another 2000 miles (the rest of the distance) becomes triple, the three parallel ridges being connected at intervals by narrow cross ridges forming *knots*, generally remarkable for extremely lofty mountain peaks, high table lands, and plains and elevated lakes. Near these knots the great rivers of South America take their rise. In absolute length no single chain in the earth approaches the Andes, and only a few of the higher peaks of the Himalayan chain rise higher above the sea level.

By the knots above mentioned the northern chain of the Andes is divided into several portions, of which the two most to the south (terminating the Bolivian Andes) are of extraordinary elevation, and are connected with the lofty plateau and lakes mentioned in the article America. From these plains rise the higher elevations, attaining the height of about 25,000 feet on the eastern or interior range, and about 22,000 feet on the western or coast range. The snow line of the chain in this latitude is about 17,000 feet. To the north the Andes of Peru are less elevated, and terminate in the knot of Loxa, whence rise the principal sources of the Amazons river, under the name of Marañon. This point is less than 8000 feet above the sea, and is one of the lowest in the chain until we approach the Isthmus of Darien. Beyond it the mountain peaks rise again to upwards of 20,000 feet, the cone of Chimborazo towering over all in the neighbourhood. This part is called the Andes of Quito. Further north the mountains are more distributed and somewhat less lofty.

There are many passes across the Andes, but they are mostly at high levels, and only accessible at certain seasons. On the eastern side the slope is more gradual than on the western, and terminates in plains of greater elevation, or in flanking ranges of hill or mountain. In the Bolivian Andes the passes are from 14,000 to 16,000 feet above the sea.

Very many of the higher peaks of the Andes are conical and volcanic, but only a few are active volcanos. Of these Cotopaxi, near Quito in the Andes of Quito, is one of those that has most frequently been described in modern times. Its height is estimated at 18,880 feet. This and the still higher elevation of Chimborazo (21,420 feet) are situated one or two degrees south of the equator. Pichincha is the name of another of the principal elevations, celebrated for having served as a signal in the measurement of an arc of the meridian by Bouguier and La Condamine. It is actually under the equator.

Little or no rain falls on the western or Pacific side of the Andes, except in the temperate latitudes near the southern extremity. In that part, however, there is not only rain, but extensive glaciers, which come down near the sea, and penetrate below the limits of the palm tree and other tropical and sub-tropical vegetation. Nothing can surpass the desolation of these regions. Further north in the Andes of Chili there are a number of volcanoes, and some extremely lofty peaks, Aconcagua, near Valparaiso, rising to 23,200 feet (as much as 10,500 feet above the snow line in that latitude).

In the higher plains of the Andes there are remarkable atmospheric effects, the landscape being without much colour, although the sky is generally quite cloudless. This arises no doubt from the thinness of the air. Changes of weather are sudden and violent, and the storms, both electric and of wind, are singularly destructive and terrible.

Andesine. A lime-and-soda Felspar resembling Albite, and entering into the compo-

sition of the rock Andesite, which occurs in the Andes of South America.

Andirons. The term used by the medieval authors to express the fire dogs which were used in places where wood was burnt. They were often made highly ornamental, and were adorned with silver and plated extremities of the most elegant character.

Andræaceæ (Andræa, one of the genera). Little moss-like plants, differing from the true mosses in the want of an operculum and peristome, and in having four-valved spore-cases.

Andreasbergolite. A name given to Harmotome, after Andreasberg in the Harz, where it was first discovered.

Andrena. The name of a Fabrician genus of bees, including those which have the tongue three-cleft, and the labium cylindrical, with two membraneous bristles on each side.

Andrœceum (Gr. ἀνήρ, *a male*, and οἶκος, *a house*). All that part of a flower to which the male organs appertain. The ring of stamens in a plant is an andrœceum; so is the fringe at the mouth of the tube in the passion flower, taken together with the true stamens. The term may be literally translated the male apparatus.

Androgynous (Gr. ἀνδρόγυνος, from ἀνήρ, *a man*, and γυνή, *a woman*). In Botany, a union of both males and females, either in the same flower, which is also called hermaphrodite, or upon the same plant, the sexes being in different flowers, as in the birch and similar trees. The latter is what Linnæus called monœcious.

ANDROGYNOUS. In Physiology, the possession of the organs of both sexes in the same individual, either naturally, as in the snail; or preternaturally, as in the free martin and similar monsters. An hermaphrodite.

Android (Gr. ἀνήρ, man, and εἶδος, *form*). An automaton which imitates the actions of man. [AUTOMATON.]

Andromeda (after the virgin Andromeda, daughter of Cepheus and Cassiope). A family of Ericaceous shrubs, many of which are cultivated for the sake of the flowers. The type species is *A. polifolia*, a dwarf plant possessing acrid narcotic properties, and found wild in boggy situations in some parts of England.

Andron (Gr). In Architecture, the suite of apartments exclusively occupied by the male part of the establishment. [GYNÆCEUM.]

Androphorum (Gr. ἀνήρ, *a man*, or, in Botany, *a stamen*, and φέρειν, *to bear*). A columnar expansion of the centre of the flower, on which the stamens seem to grow, as in the passion flower. In reality, it is formed partly of the adhering filaments, and partly of an elevation of the growing point.

Andropogon (Gr. ἀνήρ, *a man*, and πώγων, *a beard*). A genus of tropical grasses containing *A. Schœnanthus*, the sweet-lemon-grass, which yields one of the fragrant lemon-scented grass oils; *A. Calamus-aromaticus*, considered to be the sweet cane of Scripture; and *A.* (*Anatherum*) *muricatus*, the aromatic khus of India, and vetiver of the French.

Anecdote (Gr. ἀνέκδοτον, *something unpublished*). In its original sense, some particular relative to a subject not noticed in previous works on that subject. In its secondary sense, the narrative of a particular action or saying of an individual.

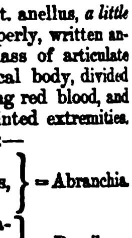
Anellata, Anellides (Lat. anellus, *a little ring*). Generally, but improperly, written annelidans or annelides. A class of articulate animals, with a long cylindrical body, divided into ring-like segments, having red blood, and respiratory organs, but no jointed extremities. They are classified as follows:—

Order *Suctoria*	. Leeches		= Abranchia.
" *Terricola*	Earthworms, Naiads.		
" *Errantia*	Nereids, Sea-centipedes, Lugworms, & Sea-mice.	= Dorsibranchiata.
" *Tubicola*	. Serpulans .	= Cephalobranchiata.

Anelytrous (Gr. ἀνέλυτρος, from ἀ, priv., and ἔλυτρον, *a sheath*). A name sometimes given to those insects which have two or four membranous wings, either naked or covered only with hairs or scales.

Anemometer (Gr. ἄνεμος, *the wind*, and μέτρον, *measure*). An instrument for measuring the force or velocity of the wind.

Dr. Lind's anemometer consists of a glass tube, bent into the form of the letter U, and open at both extremities. One of the extremities, A, is also bent round to the horizontal direction, in order that the wind may blow into it. The tube being partially filled with water and exposed to a current of air, the water in the branch at which the wind enters is depressed, for example, to B, and consequently rises in the other branch to C, and the difference, *b* C, of the levels at which it stands in the two branches is the height of a column of water, the weight of which forms a counterpoise to the force of the wind. The relative velocities of the wind are thus ascertained, the variation of the velocity being nearly proportional to the square root of the resistance. The bore of the tube is diminished at the bottom to check the undulations of the water caused by a sudden gust of wind. This instrument may be mounted on pivots, and an arrow-shaped vane attached, so that the mouth A shall be always exposed to the direct current, and thus the direction as well as the velocity of the wind indicated at the same moment.



But the anemometer most generally used is one devised by Dr. Robinson, of Armagh, and made by Casella, of London. It consists essentially of four hemispherical cups, having their diametral planes exposed to a passing current of air; they are carried by four folding horizontal arms attached to a vertical shaft or axis, which is caused to rotate by the velocity of the wind.

Dr. Robinson found that the cups, and consequently the axis to which they are attached, revolve with one third the wind's velocity. A simple arrangement of wheels and screws is appended to the instrument, which, by means of two indices, shows on inspection the space traversed by the wind in a given time.

Whewell's registering anemometer consists of a series of wheels and pinions carrying a tracing pencil which is set in motion by a small fly connected with an ordinary vane. The pencil descends $\frac{1}{10}$ th of an inch for every 10,000 revolutions of the fly, and presses against a cylinder carrying a registering paper.

Casella, by an elaborate combination of Robinson's anemometer with some recent modifications, has produced an instrument capable of registering the direction and velocity of wind with even greater accuracy than any of the above. A specimen of this anemometer was shown at the International Exhibition of 1862; its indications may be recorded in any room of the building on which it may be placed.

Anemometry. The operations connected with ascertaining and recording the direction, velocity, and other attributes of wind. [ANEMOMETER.]

Anemone (Gr. from ἄνεμος, *wind*). A genus of Ranunculaceous herbs, mostly perennials, many of them cultivated in gardens for the sake of their handsome cup-shaped flowers. The most showy is that known as the poppy anemone, *A. coronaria*. Many of them have tuberous or thickened roots.

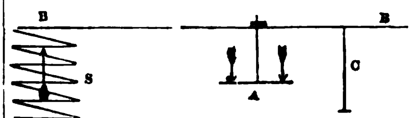
Anemonic Acid. A solid organic compound existing in the wood anemone.

Anemonin, or Anemonia. An acrid crystallizable substance obtained from some species of anemone. It burns like camphor.

Anemoscope (Gr. ἄνεμος, *wind*, and σκοπέω, *I look*). An instrument for indicating the direction of the wind. A common vane, or weathercock, is an instrument of this kind. Sometimes the vane turns a spindle which descends through the roof of the building into the chamber where the observation is to be made. An index fixed to the spindle points out the direction of the wind, on a compass card fixed to the ceiling. By means of wheel-work, the direction of the spindle, or the axis of the index, may easily be changed, so that the compass card may be placed on a wall of the chamber, or in any convenient position for observation.

Aneroid Barometer (Gr. ἀ, *without*, and νηρός, *wet*, *damp*, to distinguish it from the ordinary mercurial barometer).

The instrument may be described as consisting of three essential parts: first, an air-tight box formed of thin metallic plates, so that the sides yield to the pressure, and collapse when the air is withdrawn from the interior; secondly, a spiral spring resisting the compression of the sides of the box; and thirdly, a system of levers connected with the box and spring, and giving motion to an index by which the amount of pressure is exhibited on a scale. The arrangement is represented in the annexed diagram, in which A represents the vacuum-box, B B the main lever, C the



fulcrum or support, and S the spring; the direction of the forces being indicated by the arrows. If, at a certain pressure, the lever has the direction indicated in the figure, then, supposing an increase of pressure to take place, the upper side of the box will be pressed downwards, carrying the lever, with which it is shown to be in connexion, along with it, and consequently compressing the spring against which it acts. The lever, it will be observed, is of the second order, and, as usually constructed, the distance of the spring from the fulcrum is to that of the box from the fulcrum in the ratio of six to one.

The box is of a cylindrical form, about $2\frac{1}{2}$ inches in diameter, and 5-16ths of an inch deep, partially exhausted of air, and hermetically sealed. It is composed of thin corrugated copper-plates. The spring is formed of steel wire, about 1-20th of an inch in thickness, and the helix or coil is about an inch in height, and 5-8ths of an inch in diameter. A system of levers is employed to multiply the movement of the main lever, and to the ultimate lever is attached a piece of fine watch-chain pressing round a small roller, on the axis of which the index is placed, which exhibits the variations of pressure on a graduated dial. The index is kept in its place, and the chain in a state of tension, by means of a delicate spiral spring attached to the same axis. The whole is placed within a cylindrical box, about five inches in diameter, and the general form of the instrument resembles that of a watch.

Anethum (Gr. ἄνηθον). This genus of Umbellifers contains the common dill, *A. graveolens*, a slender fennel-like plant, with umbels of small yellow flowers succeeded by thin flat fruits, which yield up their carminative properties on distillation. Dill-water is a well-known domestic remedy for flatulence.

Aneurism (Gr. ἀνεύρυσμα, from ἀνευρύνω, *I dilate*). A tumour formed by the morbid dilatation of an artery, and which is therefore distinguished by its pulsatory motion.

Anfractuous (Lat. anfractus, *a winding*, or *curve*). In Botany, when the lobes of an anther, or the margin of any part, is folded back upon itself, and doubled and bent till all trace of its normal character is lost. The anther of a cucumber is anfractuous.

Angeiology, or Angiology (Gr. ἀγγεῖον, *a vessel*, and λόγος, *a discourse*). The doctrine of the vessels of the body.

Angel, Golden, or St. George, or St. Constantine. An ancient order of knighthood, fabulously reported to have been insti-

tuted by Constantine, but probably by the imperial house of Comnenus at Constantinople, and revived by the Emperor Charles V. The grand mastership of this order was resigned by the last representative of the house of Comnenus to that of Farnese, dukes of Parma.

Angel-water. A mixture of rose, orange-flower, and myrtle water, perfumed by musk and ambergris. It is made in Portugal.

Angelic Acid. A solid white crystalline body, found in angelica root. It may be formed by heating oil of chamomile with a caustic alkali.

Angelic Ether. A compound of angelic acid and ether.

Angelica (Gr. ἀγγελικός, *angelic*, from its supposed virtues) A tall growing Umbelliferous plant, found on the banks of rivers, and in other watery places. It grows four or six feet high, and has large compound leaves. The stalks are hollow.

Angelicin. A neutral substance found in angelica root.

Angels (Gr. ἄγγελος, a messenger). Spiritual beings ministering to God. In the Scriptures they appear as messengers, by whom God conveys his commands to men. We read also of the devil and his angels. See Milman, *Lat. Christianity*, b. iv. c. 2.

Angina (Lat. from ango = Gr. ἄγχω, *I strangle*). A disease attended with a sense of anxiety and suffocation. The term is commonly applied to certain symptoms arising from organic disease of the heart, which gives rise to a distressing difficulty of respiration, and is hence termed Angina Pectoris.

Angiocarpous (Gr. ἀγγεῖον, *a vessel*, and καρπός, *fruit*). When seed-vessels are inclosed within a covering that does not form a part of themselves, as the filbert, covered by its husk, or the acorn seated in its cupule. The word is also applied sometimes to such fungi as have their spores included in a peridium, or hollow-shell, as *Lycoperdon*.

Angiospermous (Gr. ἀγγεῖον, and σπέρμα, *seed*). When seeds are inclosed within a pericarp, as in most plants. The word is now chiefly used in opposition to gymnospermous, which means that seeds are not included in a pericarp, as in fir-trees and others. Linnæus intended to apply it in the same sense; but he contrasted it with small-lobed seed-like fruits, which he mistook for naked seeds.

Angiosporous (Gr. ἀγγεῖον, and σπορά, *a seed*). A term applied to such fungi as *Lycoperdon*, which have their spores inclosed in a hollow shell or bag.

Angiotomy (Gr. ἀγγεῖον, and τέμνω, *I cut*). The dissection of vessels.

Anglarite. A fibrous and compact phosphate of iron, of a grey colour inclining to blue, which is found at Anglar, dept. of the Haute Vienne, in France.

Angle (Lat. angulus). In Geometry, there are several kinds of angles; the simplest, and the one to which all others are referred, is a *rectilineal angle*, which, according to Euclid, is 'the inclination of two straight lines, which meet, but have not the same direction.' The point of meeting is called the *vertex* of the angle, and the lines themselves its *sides*. A clearer conception of an angle as a *magnitude*, however, is obtained by considering it as the *quantity* of *turning* around the vertex, which would have to be applied to one side in order to make it coincide with the other. To this it might be objected that the coincidence in question could be brought about by very different quantities of turning. The rotation, for instance, might be *direct* (like the hands of a watch) or *retrograde*, or it might be arrested at the first, or at any subsequent coincidence. This absence of strict definition, which might easily be remedied if desired, has, however, its own advantages, especially in trigonometry. Euclid always understands by the angle between two right lines the *least quantity* of *rotation* necessary to produce coincidence. The quantity of turning necessary to make a line coincide with its continuation has been called an *angle of continuation*; half of this is a *right angle*.

In the ordinary measurement of an angle, a complete rotation is supposed to be divided into 360 equal parts called *degrees* (°), each degree being subdivided into 60 equal parts called *minutes* (′), and each minute again into 60 parts, termed *seconds* (″).

The theoretical, or, as it is called, the *circular measure of an angle*, instead of being a *concrete* is an *abstract* number. A circle is conceived to be described around the vertex, and the *ratio* of the arc, intercepted by the sides of the angle to the radius of the circle, is taken as the measure of the angle. The assumption is justified on the ground that the ratio in question does not depend upon the magnitude of the circle, whilst for one and the same circle this ratio is proportional to the arc, and, therefore, to the angle at the centre standing on that arc.

According to the above definition the theoretical *angular unit* will be *the angle at the centre which is subtended by an arc equal to the radius.* The circumference of a circle being π times its diameter or 2π times its radius (where π represents the number 3·14159, &c. [CIRCLE]), π will be the circular measure of two right angles or 180°, and if A be the number of degrees in any other angle, whose circular measure is θ, we have the following simple formula for converting ordinary into circular measure, or *vice versâ*:

$$\frac{A^\circ}{180^\circ} = \frac{\theta}{\pi}.$$

ANGLE OF CONTACT. Called also angle of *contingence*; it is the infinitesimal angle between the rectilinear tangents to a curve at two consecutive points. When the curve is traced on a surface, the angle between two geodesic lines touching the curve at consecutive points is called the *geodesic angle of contact.* [CURVATURE, GEODESIC.]

ANGLE OF CURVATURE. The angle between

two consecutive normals of a plane curve; it is always equal to the angle of contact.

ANGLE, CURVILINEAR. In Geometry, the angle formed by the tangents to two curves at the point where the latter meet.

ANGLE, DIHEDRAL. In Geometry, the angle formed by two planes which intersect; in other words, the quantity of turning, around the line of intersection, which would be requisite in order to make one plane coincide with the other.

The angle between a right line and a plane is the quantity of turning, around the point of intersection and in a plane perpendicular to the given one, which would be required to make the line lie in the plane.

ANGLE, FACIAL. In Zoology, signifies the angle made by the intersection of two lines drawn, the one from the most prominent part of the frontal bone over the anterior margin of the upper jaw, the other from the external orifice of the ear-passage along the floor of the nasal cavity.

The internal angle of Walther was described by two lines, the one from the occipital protuberance to the *crista galli*, the other from the glabella to the root of the nose. The external angle of Mulders was formed by the intersection of Camper's facial line, with another from the basioccipital bone to the root of the nose. Daubenton's angle was described by a line going from the inferior margin of the orbit from the posterior region of the occipital foramen intersecting another following the direction of the foramen. Doornick's incisivo-occipital line was obtained by dropping a vertical line to the level of the meatus auditorius externus, crossed by another from the incisor teeth to the occipital protuberance.

ANGLE, FRONTAL. In Ornithology, signifies the angle which the culmen, or upper line of the beak, makes with the forehead.

ANGLE OF JAW. The point of intersection between the ascending and the horizontal rami of the jaw is so called. In the marsupial mammalia it is inflected inwards. The bone *angulare*, which forms this angle, is separately ossified in the lower *Vertebrata*.

ANGLES OF INCIDENCE AND REFLECTION. Terms used in Optics. [REFLECTION.]

ANGLE, SOLID. According to Euclid, 'a solid angle is that which is made by the meeting of more than two plane angles, not in the same plane, in one point.' This definition, however, is incomplete as well as vague. For we also speak of the solid angle at the vertex of a cone, and measure the same by the ratio, to the whole surface of a sphere around the vertex, of the portion of this surface intercepted by the cone.

ANGLE, SPHERICAL. In Trigonometry, the angle between two great circles of a sphere, or the inclination of the planes of these circles to each other. A spherical angle is measured by the arc of a great circle intercepted between those two points of its sides which are at the distance of 90° from the point of intersection, or the vertex of the angle.

ANGLE, VISUAL (Optics). The angle formed by two rays of light, or two straight lines drawn from the extreme points of an object to the centre of the eye. The apparent magnitude of objects depends on the magnitude of the angle under which they are seen; nevertheless, in observing distant objects, our ideas of their magnitude are greatly modified by the judgment which we form of their distances. [MAGNITUDE, APPARENT.]

Angle Iron. The piece of iron which is rolled to the shape of the letter L, intended to form the joints of plate iron for large girders or for the joints of boiler plates, &c., to which the angle iron is riveted by single or double, or chain riveting.

Anglemeter. This name has been specially given to an instrument used by geologists for measuring the dip of strata, the angles of joint-planes, &c. (*British Association Reports*, 1847)

Anglesite. A sulphate of lead produced by the decomposition of galena. It occurs in rhombic prisms, with dihedral terminations, and of a white, grey, or yellowish colour, but frequently tinged blue or green by oxide of copper, in Derbyshire, Cumberland, Leadhills in Lanarkshire, and Wanlock Head in Dumfriesshire; also in Baden, Siegen in Prussia, Silesia, Siberia, the Harz, Spain, and a mine near Coquimbo in Chili. It was first observed as a distinct species at Pary's Mine in Anglesey, whence the name Anglesite.

Anguilliform (Lat. anguilla, *an eel*, forma, *shape*). Eel-shaped fishes, or those belonging to the tribe of eels.

Anguis. The name of a genus of Saurian reptiles, characterised by having subcaudal and abdominal imbricated scales, which scales consequently form a uniform covering over the whole body. The genus is now subdivided into the subgenera *Pseudopus*, *Ophisaurus*, *Acontias*, and *Anguis*, properly so called; the reptiles comprehended under the latter denomination have the tympanum concealed beneath the skin; the maxillary teeth compressed and hooked, and no teeth on the palate. The *Anguis fragilis*, blind, or slow worm, is a well-known example of this genus.

Angular Motion. The angular motion of a point or body is the same as that of the line, or radius vector, joining the moving point to some fixed one. The *angular velocity* of the body, as referred to the fixed point, is the ratio of the angle described by the radius vector, to the time occupied by its description.

Angular Section. The division of an angle into any number of equal parts. The general division of an angle into any proposed number of equal parts is a problem which mathematicians have not yet been able to solve. In modern mathematics the term angular sections denotes that branch in which the properties of circular functions are investigated.

Angustura Bark. The bark of the *Cusparia febrifuga*, originally imported from Angustura in South America; it is occasionally

used in medicine as a tonic. A poisonous bark is occasionally found in commerce under the name of spurious Angustura, which appears to be the produce of a species of strychnos.

Anharmonic Ratio. A term of modern geometry, introduced by Charles (*Aperçu Historique*), and applied to four points on a right line, as well as to four lines through a point (a plane pencil of four rays), or to four planes through a line (pencil of four planes).

The anharmonic ratio of four points, $a\,b\,c\,d$, in a line is represented by the symbol $(abcd)$, which denotes the ratio of the ratios $\frac{ac}{cb}$ and $\frac{ad}{db}$; that is, $(abcd)=\frac{ac}{cb}:\frac{ad}{db}$. The segments here introduced are to be understood as positive or negative, according to the order in which the letters denoting them are written; thus, $ab=-ba$. Two anharmonic ratios are said to be *reciprocal* when their product, and *complemental* when their sum, is equal to unity. Now the twenty-four anharmonic ratios to which four points give rise, by changing their order in all possible ways, may be divided into six groups each consisting of four equal ratios, and such that the ratios in three groups are respectively the reciprocals of the ratios in the other three. In other words, each of the twenty-four ratios, or its reciprocal, is equal to one or other of the three *fundamental ratios* $(abcd)$, $(acdb)$, $(adbc)$. These, again, are expressible in terms of the first; in fact, the second is the reciprocal of its complement, and the third the complement of its reciprocal; so that, putting the first ratio, $(abcd)=a$, the second ratio $(acdb)=\frac{1}{1-a}$, and the third ratio $(adbc)=1-\frac{1}{a}=\frac{a-1}{a}$.

The *anharmonic ratio of four lines*, ABCD, passing through the same point (of a pencil of four rays), is represented by the symbol sin. (ABCD), which is itself defined by the equation $\sin.(ABCD)=\frac{\sin.AC}{\sin.CB}:\frac{\sin.AD}{\sin.DB}$; it being understood that AC and CA represent angles between the lines A and C which, though equal in magnitude, are opposite in sign. If $a\,b\,c\,d$ be the points in which any transversal is cut by the rays ABCD, it can be easily shown that $(abcd)=\sin.(ABCD)$. The whole modern system of geometry may be said to be founded on this equation, which expresses the *projective character of anharmonic ratios*. We learn from it, on the one hand, that the projections upon any line of any four points *in lineo* have the same anharmonic ratio as the latter; and, on the other hand, that all pencils whose rays pass through the same four points *in lineo* have the same anharmonic ratio.

The *anharmonic ratio*, sin. (ABCD), *of a pencil of four planes passing through the same line or axis*, is identical with that of the four lines in which the system is cut by a plane perpendicular to the axis, and is equal to that of the four points in which the pencil is cut by any transversal whatever, or, again, to that of the four lines in which the system is intersected by any plane whatever.

The *anharmonic ratio of four points on a conic* is identical with that of the lines joining the same to any other point of the curve, it being a property of conics that all pencils whose centres are on the curve, and whose rays pass through the four fixed points of the same, have the same anharmonic ratio. Similarly, the *anharmonic ratio of four tangents to a conic* is the invariable anharmonic ratio of the points in which these four tangents intersect any fifth.

Anhelation (Lat.). Difficulty of breathing.

Anhydrides. Bodies without water. A chemical term restricted to the anhydrous acids, or acids without water.

Anhydrite. Anhydrous sulphate of lime. It is harder and heavier than gypsum, into which it becomes slowly converted by the absorption of water.

Anhydrous (Gr. ἄνυδρος, from ἀ, priv., and ὕδωρ, water). Without water. A term often applied to salts, and to acids when deprived of water.

Anicut. An artificial dam, made in the course of a stream for the purpose of regulating the flow of a system of irrigation; under these circumstances the great anicuts which are established on the Indian rivers are always provided with bottom sluices, through which the water is let out for the regular supply. The term 'anicut' is of Indian origin, and is only used in technical works upon the irrigation of that country.

Anil. One of the plants yielding indigo.

ANIL (Sanscr. nili, *indigo*). A kind of indigo said to be a native of America, although now cultivated in the East Indies. It is very like *Indigofera tinctoria*, the true indigo, from which it chiefly differs in having compressed legumes, which are not torulose.

Aniles. Aniline, in which two atoms of hydrogen are replaced by one of a diatomic acid radical.

Anilic Acid. *Indigotic acid*, *Nitrosalicylic acid*. A solid, fusible, white crystalline body resulting from the action of nitric acid on indigo.

Anilides. Aniline, in which one atom of hydrogen is replaced by an electro-negative radical.

Aniline (from anil, the indigo plant). A colourless oil-like liquid of a strong odour and hot aromatic flavour, remarkable for its tendency to form crystallizable compounds with acids, so that it was originally termed *crystalline*. It is a product of the distillation of certain organic substances, and among others it has been derived from *indigo*. It is largely consumed in the preparation of mauve and magenta dyes, and for this purpose is derived from benzole, one of the constituents of coal tar. The formula of aniline is $C_{12}H_7N$.

Anilocyanic Acid. Cyanic acid in which hydrogen is replaced by phenyl.

Anilotic Acid. A product of the action of nitric acid upon salicin.

Anima Mundi (Lat. *soul of the world*). An expression formerly used to denote an ethereal essence or spirit, supposed to be diffused throughout the world, organising and actuating the whole and the different parts.

Animal (Lat.). The name of the higher division or kingdom of organised beings, distinguished by endowments of sensation and voluntary motion, superadded to the organic functions which animals possess in common with plants.

It has been objected to this definition, that the so-called sensitive plant is susceptible of impressions which cause action and motion of its parts, and that the embryos of *Algæ* and *Confervæ* have locomotion, while many of the lower animals are fixed as immoveably to the earth as plants. But these objections have no real value, and could only have arisen from confounding irritability with sensation, which are two very different phenomena. It is the property of all living organised beings, and essential to their existence as such, to be susceptible of the impressions of certain stimuli, which occasion a reaction of the part stimulated, and the main object of physiology is to determine the precise mode in which each organ of a plant or animal reacts when stimulated. But it is here only necessary to state, that the muscular fibre in animals reacts when stimulated by an angular puckering called contraction, and this property is termed irritability. It is independent of the nerves and of sensation, for a portion of muscle removed from an animal body manifests the same contraction when irritated, whether mechanically, galvanically, or chemically. In the living animal the most common stimulus of the muscular contraction is the operation of the nerves, excited by the will, and is commonly the consequence of an act of sensation; but this is by no means the only stimulus by which the irritable property of the muscle is or can be called into play. In plants, universally, there are also irritable parts, or parts which react when stimulated by producing motion of a part or the whole of the body. It is this property which occasions the motion of the cambium or sap; it is by the same endowment that growing plants incline to the light, and extend their roots to the most congenial soil; or entwine their tendrils around the bodies which serve as their support; or move the stamens in regular succession towards the female part or pistil (saxifrage), or incline the pistil successively to each stamen (lily). By a modification of the same irritable property some plants close their leaflets or flowers at sunset; while others, like the nocturnal animals, go to sleep, as it were, at the approach of day. By a higher degree of this irritability the leaflets of the fly-trap (*Dionæa*) approach each other, and inclose the insect which has alighted upon them; and the *Mimosa pudica* withdraws its leaves from the offending touch, while the *Desmodium* exhibits during the day a constant alternate movement of the lesser foliolcs, analogous to the quicker vibration of the cilia which beset the respiratory organs of many molluscous animals, and which is equally independent of the nerves and of the will. The conditions of all these vegetable motions, which essentially distinguish them from the voluntary movements of animals, are, that they never proceed from an internal impulse, but are invariably the consequences of external stimulus, and take place, as it were, mechanically, and in the selfsame manner; while in animals the motions arise out of an internal determination from parts not moving to the moving powers. There is also an essential difference in the nature of the motion itself, even when we compare the simplest animal with the plant. If we touch the feeler of a polype, it recedes from the irritant by a true contraction of the part within itself; but in the case of the sensitive plant, there is nothing like this contraction of the part touched, but only an articular plication of a contiguous part, without the dimensions of the irritated leaf being altered. Experiment has also shown that the intumescent parts of the mimosa, in which the irritable property is concentrated, move the leaf by an extension of cells, and not by a contraction of fibres.

It is true that many of the lower aquatic animals are rooted to the bottom: and these are often aggregated, and grow in a branched or plant-like form, as the serpularia and other corallines; but, although voluntary motion of the whole is impossible, yet it is sufficiently conspicuous in the different parts, and the vital endowments of the individual polypus manifest a multiplied animal enjoyment, not the condition of a vegetable. The simplest monad of infusions exhibits the voluntary characteristics of the animal, by varying its movements to avoid obstacles or seize its food, while the locomotive embryo of the *Conferva dilatata* proceeds blindly onwards in an unvarying course, till its irritability is exhausted, and excites no idea of animality in the mind of an observer who has had any experience in the observation of animalcules. Ehrenberg has asserted that he can distinguish a moving embryo of the *Algæ* from a polygastric monad, as easily as a tree from a bird.

The nerves are the organs on which spontaneous motion and sensation depend, and they chiefly distinguish the animal from the vegetable. Hence the nervous system has been termed the essence of an animal. All the other systems of organs appear in their plan of arrangement to be subject to the modification of the nervous system; and it is upon this system, therefore, that, in the classification of animals, their primary division is founded. Recent and more accurate researches have proved the existence of nerves in many of the lower organised animals, where their presence had been denied; and as, in every species in which the nerves have been detected, sensation has been found to depend exclusively upon them, we are hence led to assume that all animals in which sensation is observable, must

have it depending on nervous matter present in some condition or other in their tissue; even where, as in the freshwater polype, this is apparently homogeneous, and where, from the extreme divisibility of the individual without loss of vitality in the detached parts, we may reasonably conclude the nervous molecules to be dispersed throughout the corporeal mass.

The attributes of sensation and voluntary motion modify, as might be expected, all the other functions which animals possess in common with plants. For example, as regards nutrition, vegetables which are fixed to the soil absorb immediately by their root the nutritive parts of the surrounding fluid. These roots are indefinitely subdivided; they penetrate the smallest interspaces, and seek, as it were, at a distance the nourishment of the plant to which they belong. Their action is tranquil, but unintermitting; being only interrupted when dryness has deprived them of the juices which are necessary for them.

Animals, on the contrary, which are rarely stationary, but which have the power of moving not only parts of the body, but the entire body, from place to place, require the means of transporting the provision necessary for their subsistence; accordingly, they have received an internal cavity, appropriated for the reception of the nutriment, and upon the parietes of which open the pores of the absorbent vessels, which have been justly compared to internal roots.

An internal cavity is requisite for animals on another ground;—their food must first be digested. Plants are supported by water containing carbonic acid, or the already dissolved organised material of the soil. But nutrition in animals does not immediately commence by the absorption of such fluids as the soil or the atmosphere furnishes, but their food consists of substances already in organic combination, which must be prepared and submitted to instruments for dividing and comminuting it, and to the action of solvent fluids. Thus digestion, or the preparatory assimilation of the food, is entirely peculiar to animals. They alone are endowed with organs of sensation, which guide them in the choice of aliment. They alone possess labial and other prehensile organs for seizing the food; teeth and jaws for comminuting and destroying its vitality if living; muscular actions, by which it is swallowed; and a reservoir for its reception endowed with chemical and vital powers for dissolving and assimilating such parts as are proper for nourishment, and which are selected and taken into the system through the purely vital sensibilities of the absorbent internal surface, while such parts as are unfit for nourishment are expelled.

A still more important difference, in connection with the digestive functions, arises out of the limitation of the powers of assimilation in the animal kingdom. Animals can convert into their own substance only matter which has already been organised; while plants have the power of assimilating the inorganic binary compounds, carbonic acid and water. This property of plants is more important than perhaps at first sight might be suspected; for in the vital operations of animals a great quantity of organised matter is constantly decomposed, and is rendered, at all events, useless as nutriment for other animals; while, by means of combustion and other decomposing processes, an incalculable quantity of vegetable matter is continually resolved into binary compounds, or the ultimate elements of matter: hence, if the power of producing new ternary organised compounds out of carbonic acid and water had not been given to plants, both these and animals must, in process of time, inevitably have been annihilated, and successive creations of animals and vegetables would have been indispensable to maintain the present system of things. It is a beautiful instance of the harmony which pervades the relations of nature, that animals contribute as essentially to the support of vegetables, by a process of excretion, as these to the maintenance of animal life, by their powers of assimilation. The product of the respiratory interchange which takes place between the circulating fluids and the atmosphere in animals, is carbonic acid, which is an essential aliment of plants, and which plants, when in health and exposed to the influence of the sun's rays, absorb from the atmosphere by their respiratory organs, the leaves exhaling the superfluous oxygen which is extricated in their assimilative processes. Thus the constitution of the atmosphere is maintained by the different products which are evolved in the respiratory processes of plants and animals.

The circulation of the nutrient juices is much more independent of the external influences of light and heat in animals than in plants; and in most classes of the animal kingdom, the motion of the blood is principally determined by the contraction of an express muscular organ called the heart.

From a general review, therefore, of the nature and properties of living animals, their distinguishing characteristics may be summed up as follows:—

Animals are the only beings in nature which manifest sensation and spontaneous movements. They digest organised substances alone, and are always provided with a mouth, and an internal digestive cavity or canal.

Their nutrient fluids are received by an absorbent internal surface; while in plants they are taken up by an absorbent external surface.

Animals at all times, in respiration, exhale carbonic acid and absorb oxygen.

The tissues developed by animals comprise, as proximate principles, the quaternary compounds of carbon, hydrogen, oxygen, and nitrogen.

The two divisions of organisms called 'plants' and 'animals' are specialised members of the great natural group of living things; and there are numerous beings, mostly of minute size and retaining the form of nucleated cells, which manifest the common organic characters, but

without the distinctive superadditions of true plants and animals. Such organisms are termed '*Acrita*' or '*Protozoa*,' and include the *Amorphozoa* or Sponges, the *Rhizopoda* or foraminifers, the *Polycystineæ*, the *Diatomaceæ*, the *Desmidiæ*, *Gregarinæ*, and most of the *Polygastria* of Ehrenberg, or infusorial animalcules of older authors. [ACRITA, PROTOZOA, and ZOOLOGY.]

Animal Substances. The principal products of the animal kingdom are chemically characterised by the presence of nitrogen as one of their ultimate elements, which is generally in combination with carbon, hydrogen, and oxygen. When, therefore, they are subjected to destructive distillation, ammonia is a common product; it is also often evolved when they are triturated with caustic potash, or quicklime.

Animalcules. [ACRITA, INFUSORIES, and PROTOZOA.]

Anime. A resin which exudes from the *Hymenæa Courbaril*. It is brought from South America. It was formerly used in medicine, but is inert.

Animé. In Heraldry, when the eyes of any rapacious animal are borne of a different tincture from the creature itself.

Anions (a word formed from Gr. ἀνά, *upwards*, and ἰών, a participle of the verb εἶμι, *to go*). Substances which in electro-chemical decompositions are evolved from their combinations at the surface by which the electricity is supposed to enter the electrolyte. [ELECTRODE.]

Anisamic Acid. White crystals derived from nitranisic acid, by the action of sulphide of ammonium.

Anisamide. Ammonia in which an atom of hydrogen is replaced by one of the negative radical anisyl.

Anisanilide. Anisamide in which an atom of hydrogen is replaced by phenyl.

Anise (Arab. anisun; Gr. ἄνισον = ἄνηθον). The aromatic fruit of an eastern annual umbelliferous plant called *Pimpinella anisum*. It is principally employed in the manufacture of liqueurs, and against flatulence. *Star-anise* is the produce of *Illicium anisatum*, a tree belonging to *Winteraceæ*.

Anisette. A French liqueur, made by distilling anise, fennel, and coriander seed with brandy, and sweetening the product.

Anishydramide. A crystalline solid, product of the action of ammonia on hydride of anisyl.

Anisic Acid. Crystals formed on treating oil of aniseed with nitric acid.

Anisic Ether. A compound of anisic acid and ether.

Anisobryous (Gr. ἄνισος, *unequal*, and βρύω, *I grow*). A name given by some writers to Monocotyledonous plants, which, having only one cotyledon, grow at first with more force on one side of their axis than on the other.

Anisodactyles, Anisodactylæ (Gr. ἄνισος, *unequal*, and δάκτυλος, *a digit*). The name given by Temminck to an order of birds including those insessorial species the toes of which are of unequal length, as in the nuthatch.

The term has been also applied to the odd-toed section of Ungulate Mammalia, in which the toes are of unequal number. [PERISSODACTYLA.]

Anisodynamous (Gr. ἄνισος, *unequal*, and δύναμις, *power*). A name given to Monocotyledonous plants, for the same reason as Anisobryous [which see].

Anisoin. A resinous body, formed by the action of oil of vitriol on oil of aniseed.

Anisostemonous (Gr. ἄνισος, *unequal*, and στῆμων, *a stamen*). When the number of stamens in a flower neither corresponds with the calyx nor corolla in number or power; as, for instance, when a flower having five sepals has three or seven stamens, in which case the stamens are equal neither to the number of sepals nor any power of their number.

Anisotomidæ (Gr. ἄνισος, *unequal*, and τέμνω, *I cut*). A family of Coleopterous insects, having moniliform, or beaded, antennæ, subelongate, slender at the base, gradually increasing towards the apex, with a terminal club-shaped multiarticulate joint; palpi various, generally filiform; head small and ovate; body convex, never linear. This family includes eight genera: *Tritoma*, of which we have one indigenous species, *Tr. bipustulatum*; *Phalacrus*, of which Stephens describes twenty-eight British species, remarkable for their brilliant colours, and faculty of rolling up the body into a ball; *Ephistemus*, of which only three species are known, which have been detected in the neighbourhood of London; *Leiodes*, abundant in species, of which twenty-six are British; *Agathidium*, of which we have twelve species, inhabiting putrid wood and fungi, also found near London; *Clambus*, of which various species, all extremely minute, are known; *Clypeaster*, a term already appropriated to a genus of *Echinidæ*; lastly, *Sericoderus*; distinguishable from the rest of the family by its truncate elytra.

Anisyl. The hypothetical radical of anisic acid and its derivatives.

Anker. A measure of wine or spirits equal to 10 of the old gallons, or 8½ imperial gallons, = 2310·6 cubic inches.

Ankerite. A crystallized variety of Dolomite containing a large proportion of iron, found near Torness in the Orkneys, in amygdaloid. It is much prized as an ore of iron for smelting, and as a flux.

Annabergite. A hydrated arseniate of nickel, occurring in apple-green capillary crystals at Annaberg.

Annals. A chronological history: derived from the Roman *Annales Pontificum* or *Annales Maximi*, which were annual records of passing events connected with religious observances, kept by the Pontifex Maximus.

Annals are a species of historical writing; but they seem, notwithstanding, to differ materially from history, as the latter is now understood. Annals should comprise a succinct account of the events having reference to some

peculiar subject, as they occur in successive years. Inquiries as to the remote causes and consequences of events seem to be misplaced in them; though they are the essence of history. Cicero, when speaking of annalists, says, '*Unam dicendi laudem putant esse brevitatem, non exornatores rerum, sed tantum narratores.*' Annals are, in fact, rather materials *for* history than history. In the one, events only are narrated, in the other they are narrated and reasoned upon.

Annates or **First Fruits.** A fine paid to the king, as head of the church, by one promoted to an ecclesiastical benefice, and supposed to amount to one year's value of that benefice. This, however, is evaded by assuming as the basis of the valuation that made in 1535, and contained in what is termed the *Liber Regis.* In England, first-fruits go to the augmentation of Queen Anne's bounty.

Anne (St.) Order of. An order of knighthood, originally established in Holstein, and carried with the princes of that country into Russia. It was made a Russian order in 1796, and is now widely diffused.

Annealing (A. S. anælan, *to heat*). There are many substances which, when rapidly cooled, after having been heated, become exceedingly brittle,—an inconvenience often prevented by very slow cooling. This is especially the case with glass, which is therefore suffered to cool very gradually in an oven constructed for the purpose, and the process is called annealing. Many of the metals which have become harsh and hard in the process of manufacture, are softened in the same way; thus the blank pieces for coinage, several metallic wires, &c. are annealed.

Annihilator, Fire. An instrument in which a large quantity of non-combustible gas, chiefly carbonic acid, can be quickly generated. Directed on burning matters, this gas stops combustion by excluding air.

Anniversary (Lat. anniversarius). In Ecclesiastical usage, the day of the year on which an office is celebrated in honour of a deceased person. Hence, the annual return of any remarkable day. The services for 'anniversary days' of political significance, in the Church of England (Jan. 30, May 29, Nov. 5, Oct. 23) were abolished by Act of Parliament in 1859.

Annivite. An impure variety of Grey Copper, found in the valley of Anniviers, in Switzerland, with Copper Pyrites.

Annona (Lat.) In Roman writers, means, in a general sense, the year's increase, or the fruits of the year; and it also means the contribution or tax payable in corn, imposed on some of the more fertile provinces of the empire, as Sicily, Egypt, &c., for the use of the army and of the capital. The office of Præfectus Annonæ was of great importance at Rome, and continued down to the latest times of the empire.

Annotta, Annotto. Is the pulp of the seeds of the *Bixa Orellana*, an Exogenous tree common in Cayenne and other parts of America; it is made into a pulp, which, after having fermented, is rolled into pieces of two or three pounds' weight: it is imported under the names annotto, Roucou, or Orleans, and is used occasionally as an orange dye and for colouring cheese. It imparts little colour to water, but dissolves in alcohol and in alkaline solutions; its colour is not materially altered by acids or alkalies.

Annuaire. A name given by the French to publications on continuous or similar subjects, which appear in yearly parts or numbers. Of the existing *Annuaires*, that published by the *Bureau des Longitudes* is the most celebrated. There are also an *Annuaire Historique*, corresponding to our *Annual Register*, an *Annuaire de l'Etat Militaire*, an *Annuaire du Clergé de France*, &c.

Annual (Lat. annualis, from annus, *a year*). A plant which arrives at perfection, passing from a seed into a perfect plant, yielding its fruit, and perishing, within the space of a year. The term also applies to cases where duration is for one growing season only. Many plants have perennial roots and annual stems, that is, stems perishing and being renewed annually: such plants are usually denominated Herbaceous, in contradistinction of shrubs and trees, which have more durable stems.

Annuity. A rent or sum receivable yearly for a term of years.

An annuity may be receivable during a definite number of years, or during a period of uncertain length; for example, during the life of one or more individuals. In the former case it is called an *Annuity Certain*; in the latter, a *Contingent Annuity*.

An annuity which is not to be entered upon immediately, but after a certain number of years, is called a *Deferred Annuity*; if it is not to be entered upon till after the death of some person or persons now living, it is called a *Reversionary Annuity*. When limited by the duration of a given life or lives, it is called a *Life Annuity*; and when it is to continue only for a term of years, provided an individual or individuals now living shall survive that term, it is called a *Temporary Life Annuity*.

The practice of raising or investing money on annuities is attended with many advantages in the ordinary affairs of the world. A merchant or trader thus finds the means of clearing off his engagements gradually by the profits of his trade, and without losing possession of the capital necessary for carrying on his speculations; and one who possesses unemployed capital is thus enabled to convert it into an equivalent annual income for life, and thereby derive the utmost benefit from it while he lives, without risk of destitution from its failure. The accurate determination of the value of annuities in present money is therefore a subject of very considerable importance. We propose to explain the principles on which the calculation is made, and to apply them to a few of the cases of most frequent occurrence.

Annuities Certain.—The values of annuities

of this kind depend only on the rate of interest of money, and the number of years during which they are payable, and are easily calculated. Suppose it were required to determine the value, in present money, of an annuity of 100*l.* per annum, to continue five years, or till five payments have been made, the interest of money being 5 per cent., we should reason as follows:—The first payment of 100*l.* becomes due at the end of a year from the present time; but since 100*l.* in hand is equal to 105*l.* receivable at the end of a year, the present value of the first annual payment is 100*l.* reduced in the proportion of 100 : 105, or of 1 to 1·05; that is, it is equal to $\frac{100}{1{\cdot}05}l.$ In like manner, the present value of 100*l.*, to be received at the end of two years, is less than if it were receivable at the end of one year, in the proportion of $\frac{1}{1{\cdot}05}$; consequently, the present value of 100*l.*, to be received at the end of two years, is $\frac{100}{(1{\cdot}05)^2}l.$ Pursuing the same reasoning, the present value of 100*l.*, to be received at the end of three years, is $\frac{100}{(1{\cdot}05)^3}l.$; at the end of four years it is $\frac{100}{(1{\cdot}05)^4}l.$; and so on till the end of the term. But it is evident that the present value of the whole annuity is the sum of the values of all the annual payments; hence the required value of the proposed annuity is—

$$\frac{100}{1{\cdot}05}+\frac{100}{(1{\cdot}05)^2}+\frac{100}{(1{\cdot}05)^3}+\frac{100}{(1{\cdot}05)^4}+\frac{100}{(1{\cdot}05)^5}$$

This reasoning may be easily generalised. Let a denote the annual payment, r the rate of interest, n the number of years during which it continues, and s the present value of all the payments, we shall then have—

$$s=\frac{a}{1+r}+\frac{a}{(1+r)^2}+\frac{a}{(1+r)^3}\cdots+\frac{a}{(1+r)^n}.$$

For the sake of abridging, put $v=\frac{1}{1+r}$, and the formula will become—

$$s=a\,(v+v^2+v^3\,\ldots\ldots\ldots+v^n).$$
$$\text{or } s=a\,v(1+v+v^2+v^3\ldots+v^{n-1}).$$

The sum of the series within the parenthesis is $\frac{1}{1-v}(1-v^n)$; therefore, $s=\frac{a\,v}{1-v}\,(1-v^n)$; or, writing $\frac{1}{r}$ for $\frac{v}{1-v}$, $s=\frac{a}{r}\,(1-v^n)$.

From this it is easy to understand the method of proceeding in all other cases of annuities certain. For instance, let it be required to find the present value of an annuity deferred for three years, that is, not to be entered upon till after the end of three years; and to continue ten years from that time. It is evident that we have only to find the value of an annuity of the same amount for thirteen years, and also for three years, and to subtract the latter value from the former. The difference is the value of the deferred annuity. Again, suppose that the annuity, instead of being payable yearly, is to be paid half yearly, or quarterly. It is obvious that an annuity of 100*l.* per annum for ten years, to be paid in half-yearly payments, the interest of money being 5 per cent., is the same thing as an annuity of 50*l.* per annum for twenty years, payable yearly, interest being 2½ per cent.; or an annuity of 25*l.* per annum, payable yearly for forty years, interest being 1¼ per cent. The principle of the calculation is the same in all the cases.

Life Annuities.—When the annuity is to cease with the life of an individual, or any number of individuals, the calculation of its value is a little more complicated, as it becomes necessary not only to find the present value of the payment to be made at the end of any given year, but also to take into account the probability of its being received, that is to say, the probability that the individual or individuals, on the duration of whose lives it depends, will be alive at that period. Let the annuity depend on the continuance of a single life, and let us denote the probability that the life will be in existence at the end of

	1,	2,	3,	4,	5, &c. years,
by	p_1,	p_2,	p_3,	p_4,	p_5, &c.;

and, as before, let $v=\frac{1}{1+r}$. The present value of 1*l.*, to be received certainly at the end of a year, is v; but the probability of receiving it is p_1; therefore the value of 1*l.* at the end of the year, subject to the chance of the given life being then in existence, is p_1v. In like manner, the value of 1*l.*, to be received certainly at the end of two years, is v^2; and the chance of its being received is p_2; therefore, the value subject to the contingency is p_2v^2, and so on. Let A denote the value of 1*l.* to be received yearly during the whole continuance of the given life, we have evidently

$$A=p_1v+p_2v^2+p_3v^3+p_4v^4+\&c.$$

continued till p becomes nothing, or till the extremity of human life.

It is now necessary to consider the nature of the quantities represented by p_1, p_2, p_3, &c., and to show in what manner they are to be computed. By the doctrine of chances, the probability of the occurrence of any event is measured by the quotient that arises from dividing the number of chances favourable to its occurrence by the whole number of ways in which it can happen. Consequently, if n denote the number of individuals living at a given age, n_1 the number of the same individuals alive at the end of one year, n_2 the number living at the end of two years, n_3 the number living at the end of three years, and so on, we shall have $p_1=\frac{n_1}{n}$, $p_2=\frac{n_2}{n}$, $p_3=\frac{n_3}{n}$, $p_4=\frac{n_4}{n}$, and so on. The numbers n, n_1, n_2, &c., are taken from a table of mortality, or a table constructed to show the ratio of the number of individuals who enter upon every given year of life to the number who survive that year, or who die in the course of it.

There is no other method of finding the

value of the series represented by A than that of calculating the value of its different terms separately, and adding the whole into one sum. Nevertheless, as the object in general is not to determine merely the value of an annuity on a life at a particular age, but to construct a table showing its value for all the different ages of life, there is a method of deducing the value at one age from the value at another age, which greatly abridges the labour of calculation. Thus, suppose the age of the individual on whose life the annuity depends to be 40, and the probabilities of a life of 40 continuing 1, 2, 3, &c. years to be p_1, p_2, p_3, &c., we have, by what is already shown,

$$A = p_1 v + p_2 v^2 + p_3 v^3 + \ldots\ldots + p_x v^x.$$

Now, let A_1 be the annuity on a life of 41, that is, one year older than the former; and let the probabilities of a life of 41 living over 1, 2, 3, &c., years be q_1, q_2, q_3, q_4, &c., we shall have

$$A_1 = q_1 v + q_2 v^2 + q_3 v^3 \ldots\ldots + q_4 v^{x-1}.$$

But the quantities q_1, q_2, q_3, &c., are not independent of p_1, p_2, p_3, &c.; the one set are evidently functions of the other. In fact, the probability that a life of 40 will live over 2 years is equal to the probability that a life of 40 will live over 1 year, multiplied into the probability that a life of 41 will live over 1 year. This is evident from the manner in which the probabilities are obtained; for n, n_1, n_2, being the numbers respectively alive at the ages of 40, 41, and 42, the probability that a life of 40 will live over 1 year is $\frac{n_1}{n}$, and that it will continue 2 years, $\frac{n_2}{n}$ or $\frac{n_2}{n_1} \times \frac{n_1}{n}$. In like manner, the probability of a life of 40 living over 3 years is equal to the probability of a life of 40 living over 1 year multiplied into the probability that a life of 41 will live over 2 years; and so on. Hence, $p_2 = p_1 q_1$, or $q_1 = \frac{p_2}{p_1}$, $q_2 = \frac{p_3}{p_1}$, $q_3 = \frac{p_4}{p_1}$, and so on. We have, therefore,

$$A_1 = \frac{1}{p_1}\left(p_2 v + p_3 v^2 + p_4 v^3 \ldots\ldots + p_x v^{x-1}\right);$$

and, multiplying both sides by $p_1 v$,

$$p_1 v A_1 = p_2 v^2 + p_3 v^3 + p_4 v^4 \ldots\ldots + p_x v^x.$$

On subtracting this equation from

$$A = p_1 v + p_2 v^2 + p_3 v^3 + p_4 v^4 \ldots\ldots + p_x v^x,$$

we get $A - p_1 v A_1 = p_1 v$, whence $A = p_1 v(1 + A_1)$. This formula, which was found by the celebrated Euler, gives the following rule for determining the value of an annuity on a life at any age from the value of the same annuity on a life one year older, and renders the computation of the whole table not much more laborious than the direct calculation of the annuity on the youngest life. 'Add one to the value of an annuity on a life one year older; multiply the sum by the probability that the given life will live over one year, and also by the present value of 1*l.* to be received at the end of a year. The product is the value of the annuity on the given life.'

The values of deferred and temporary annuities on single lives are easily found from the table of the values for the whole of life. For example, let it be required to determine the present value of an annuity on the life of an individual now aged 40, but deferred 10 years, that is to say, not to commence till the expiration of 10 years. After the 10 years, if the individual be then alive, the value of the annuity on the remainder of his life is the annuity on a life of 50: let this be called B. The present value of 1*l.* payable at the end of 10 years is v^{10}; and the probability of receiving it, in the event of an individual now aged 40 being then alive, is p_{10}; therefore, the present value of B. subject to the contingency, is $p_{10} v^{10} B$. In general, the value of an annuity deferred n years is $p_n v^n A_n$ where A_n represents the annuity on a life n years older than that corresponding to A.

A temporary annuity on a single life for n years is found by adding together the first n terms of the series

$$p_1 v + p_2 v^2 + p_3 v^3, \text{ \&c.}$$

But it is frequently more easy to find it by means of the deferred annuity on the same life for the same term of years; for it is obvious that the temporary annuity and deferred annuity are, together, equal to the whole annuity. Thus, let A be an annuity for the whole of life, A_{tn} a temporary annuity of the same amount for n years on the same life, and A_{dn} the same annuity deferred n years, we shall have $A_{tn} = A - A_{dn}$.

Annuities on Joint Lives.—The method of calculating annuities, to be paid so long as two or more individuals shall continue to live together, is equally simple. Let the probabilities that A and B will live over

	1,	2,	3,	4, &c., years
be	p_1,	p_2,	p_3,	p_4, &c.
	q_1,	q_2,	q_3,	q_4, &c.

respectively, then the probability that both will live over

1, 2, 3, 4, &c., years

will be $p_1 q_1$, $p_2 q_2$, $p_3 q_3$, $p_4 q_4$, &c.,

and the value of an annuity on their joint lives which we may denote by AB. becomes

$$AB = p_1 q_1 v + p_2 q_2 v^2 + p_3 q_3 v^3 + p_4 q_4 v^4 + \text{\&c.},$$

continued till p or q becomes nothing, or to the last age in the table. When more lives than two are involved, the method of proceeding is obvious.

Another question of this kind frequently occurs, namely, to determine the value of an annuity on the survivor of two or more lives. Let us suppose two lives only are concerned: and let A be the value of the annuity on the first life, B that on the second, and AB that on the joint lives (i. e. to be paid till one of the lives shall drop). Let p_x = the probability the first will live over x years, and q_x = the probability the second will live over x years. We shall then have

$1 - p_x$ = probability 1st will die before the end of x years,

$1 - q_x$ = prob. 2d will die before the end of x years,

$(1-p_x)(1-q_x)=$ prob. both will die before the end of x years;
and hence the probability that both will not die before the end of x years is $1-(1-p_x)(1-q_x)$, which is equal to $p_x+q_x-p_x q_x$. This expression, therefore, is the measure of the probability that a payment will be received at the end of the xth year; and supposing the annuity to be 1*l*., the present value of that payment certain is v_x. Multiplying this into the above probability, we get the value in present money of the payment to be made at the xth year, if one or both of the lives survive, viz.

$$p_x v^x + q_x v^x - p_x q_x v^x.$$

Now, if we substitute successively the numbers 1, 2, 3, 4, &c. for x in this expression, we shall have the value of the 1st, 2d, 3d, 4th, &c. payment, and the sum will be the value of the annuity to continue during the life of the survivor. But it has been shown that

$$p_1 v^1 + p_2 v^2 + p_3 v^3 + p_4 v^4 + \&c. = \text{A},$$
$$q_1 v^1 + q_2 v^2 + q_3 v^3 + q_4 v^4 + \&c. = \text{B},$$
$$p_1 q_1 v^1 + p_2 q_2 v^2 + p_3 q_3 v^3 + p_4 q_4 v^4 + \&c. = \text{\textit{M}};$$

therefore the value of the annuity is $\text{A}+\text{B}-$ *M*; that is to say, *the value of an annuity on the survivor of two lives is equal to the sum of the annuities on each of the single lives diminished by the annuity on the joint lives.* [For applications of the doctrine of annuities, see the terms ASSURANCE, SURVIVORSHIP.]

Annuity Tables.—In consequence of the numerous and important applications of the doctrine of life annuities to commercial purposes, great pains and labour have been bestowed in the formation of tables of their values at all the different ages of human life. These tables differ very considerably, not from any difference in the methods of constructing them, but from the difficulty of estimating with numerical precision the probable duration of human life. The first table of the kind which we possess was given by Dr. Halley, in a paper inserted in the *Philosophical Transactions* for 1693, and founded on observations of mortality made at Breslaw. De Moivre, in a tract entitled *Annuities on Lives*, published in 1724, gave a very elegant formula for determining the value of a life annuity at any age, founded on the hypothesis that the annual decrements of life are equal; or that out of a given number of individuals, equal numbers die every year, till all become extinct. In 1742, Thomas Simpson published tables of annuities on single and joint lives, calculated from observations of mortality made in London. These were extended in a supplementary work published in 1752. Deparcieux, in 1746, published his excellent *Essai sur les Probabilités de la Durée de la Vie Humaine*, with tables of annuities on single lives, calculated from the probabilities deduced from the registers kept in different religious houses, and the lists of the nominees in the French Tontines. These tables were decidedly the best that had then appeared, and even now, when much more extensive observations have been obtained, are of great value. But the tables which acquired the most extensive reputation were the celebrated Northampton Tables, calculated by Dr. Price from registers kept in the city of Northampton. These, till a late period at least, have formed the guide of the transactions of all the assurance offices. They give the probabilities of life, and consequently the value of the annuities, considerably lower than all other good observations have subsequently proved them to be; but, in proportion as the annuities are too low, the premiums for assurance deduced from them are too high; and hence they were extremely safe for the offices, though proportionally unjust for the assured. In consequence of the competition resulting from the recent great increase in the number of assurance offices, they now transact their business on more equitable terms. An extensive set of annuity tables was given by Mr. Milne in his *Treatise on the Valuation of Annuities and Assurances on Lives and Survivorships*, published in 1815. One of these tables, founded on observations made at Carlisle, has acquired considerable reputation, and perhaps gives a nearer representation of the value of life at present in England generally than any other which has yet been published. The

VALUE of a LIFE ANNUITY of 1*l*., Interest being 4 per Cent.

Age.	Male.	Female.	Age.	Male.	Female.
1	19·0666	19·8135	46	13·5483	15·0661
2	19·1912	19·8981	47	13·2814	14·8548
3	19·2642	19·9512	48	13·0048	14·6381
4	19·2880	19·9795	49	12·7199	14·4022
5	19·2699	20·0008	50	12·4299	14·1610
6	19·2162	19·9902	51	12·1385	13·9061
7	19·1324	19·9549	52	11·8571	13·6409
8	19·0284	19·8923	53	11·5789	13·3656
9	18·9098	19·8070	54	11·3065	13·0816
10	18·7817	19·7014	55	11·0392	12·7904
11	18·6435	19·5791	56	10·7751	12·4952
12	18·4962	19·4485	57	10·5151	12·1946
13	18·3394	19·3159	58	10·2551	11·8888
14	18·1738	19·1848	59	9·9907	11·5778
15	18·0044	19·0594	60	9·7207	11·2609
16	17·8366	18·9587	61	9·4379	10·9328
17	17·6782	18·8663	62	9·1411	10·5983
18	17·5330	18·7797	63	8·8330	10·2597
19	17·4057	18·6962	64	8·5246	9·9186
20	17·2948	18·6130	65	8·2168	9·5765
21	17·1986	18·5230	66	7·9077	9·2328
22	17·1306	18·4298	67	7·6196	8·8903
23	17·0683	18·3329	68	7·3348	8·5476
24	17·0059	18·2320	69	7·0520	8·2022
25	16·9400	18·1278	70	6·7745	7·8580
26	16·8675	18·0175	71	6·5042	7·5256
27	16·7730	17·9043	72	6·2400	7·1980
28	16·6705	17·7878	73	5·9738	6·8762
29	16·5606	17·6683	74	5·6967	6·5655
30	16·4438	17·5456	75	5·4103	6·2640
31	16·3202	17·4172	76	5·1149	5·9590
32	16·1904	17·2861	77	4·7787	5·6707
33	16·0522	17·1526	78	4·4448	5·4058
34	15·9049	17·0171	79	4·1248	5·1617
35	15·7488	16·8795	80	3·8117	4·9358
36	15·5849	16·7439	81	3·5074	4·7307
37	15·4153	16·6047	82	3·2174	4·5213
38	15·2401	16·4607	83	2·9251	4·2922
39	15·0608	16·3113	84	2·6312	4·0372
40	14·8752	16·1560	85	2·3495	3·7511
41	14·6822	15·9927	86	2·0782	3·4410
42	14·4759	15·8229	87	1·8458	3·1139
43	14·2612	15·6461	88	1·6489	2·7743
44	14·0352	15·4615	89	1·4837	2·4371
45	13·7975	15·2686	90	1·3346	2·1133

annuities granted by government are now valued according to a table calculated by Mr. Finlaison from the mortality experienced among the different classes of annuitants. This table possesses a great advantage over most others, inasmuch as it is founded on observations of the actual numbers who entered upon and passed through the several years of age among a class of individuals none of which could be lost sight of, so that no uncertainty remains about the accuracy of the data. The values of the annuities are in general considerably higher than those given by the Northampton Table, at the same rate per cent., and approach to those of the Carlisle Table. The observations also indicate a considerable difference between the values of male and female life at the same ages; a fact which appears to be borne out by all the accurate registers of mortality which have been kept in this and other European countries. [MORTALITY.]

The preceding table, extracted from Mr. Finlaison's Report to the Lords Commissioners of the Treasury (March, 1829), shows the value of a life annuity of 1*l.* at all the different ages of male and female life to 90, according to the mortality among the government annuitants, the rate of interest being 4 per cent.

ANNUITY. In Law, a sum of money paid yearly, and charged on the personal estate, or on the person, of the individual from whom it is due: thus differing from a rent-charge, which is charged on real estate. Annuities are commonly employed as a system of borrowing and lending; the borrower of the money being the grantor of the annuity, and the lender the grantee. An annuity is either for a term of years, for a life or lives, or in perpetuity; and the latter, although charged on personal property, may by the terms of the grant descend as real estate. A perpetual annuity is redeemable by the grantor, subject, however, to conditions in the grant, by which he may preclude himself from redeeming for a certain period of years. An annuity for life or years is only redeemable by consent of the parties, unless it has been rendered redeemable on specific conditions in the original grant. Annuities for life, on account of the risk to which the grantee is exposed, were not within the usury laws: they were, therefore, formerly commonly resorted to as a mode of raising money by loan at high interest. By the stat. 53 G. 3, c. 141, a memorial of every instrument by which annuities for life are granted, must be enrolled in the Court of Chancery, containing the date, names of parties and witnesses, and conditions of contract, and the grantor may have the instrument cancelled, if the consideration money is not *bonâ fide* paid him. This act is intended to relate only to annuities granted in return for loans. Annuities created by will are general legacies, and subject to abatement, in proportion with other legacies, on a deficiency of the funds of the testator. If a person on whose life an annuity is charged dies between two days of payment, the grantee has no claim pro rata for the proportionate amount of the yearly or quarterly sum incurred since his death. This act is further explained by 3 G. 4, c. 92; 7 G. 4, c. 75.

Annular Eclipse. An eclipse of the sun, in which the moon conceals the whole of the sun's disk, excepting a bright ring all round the border. [ECLIPSE.]

Annulate (Lat. annulus, *a ring*). Formed or divided into distinct rings, or marked with differently coloured annulations.

Annulet. Any small member which is inserted under the architectural decorations of a capital, without much reference to the character of the profile of the members themselves. Properly speaking, the term ought to be confined to the four or five fillets under the echinus of the Doric order; but by extension it is made to express the same mouldings upon capitals of every description, even of mediæval architecture. The columns in the Temple Church and in Salisbury Cathedral are said to be 'annuleted,' because connected by a species of clustered annulet.

Annulosa (Lat. annulus, *a ring*). A term used to designate, sometimes a part, sometimes the whole, of the articulate division of Invertebrate animals. [ARTICULATA.]

Annulus (Lat.). This word is used in Botany in several different senses. In the mushroom and some other fungi it is applied to a collar which surrounds the stipes just below the hymenium; in mosses it signifies a rim external with respect to the peristome; in ferns it is an elastic rib which girds the theca or spore-cases nearly all round, and which by its contraction tears them open and disperses the spores.

ANNULUS. In Geometry, denotes a solid formed by the rotation of a circle around a line in its own plane, but not cutting it. The area of the annular surface, as well as the volume of the annulus, may be found by the general rules applicable to surfaces of rotation. [QUADRATURE and CUBATURE.]

Annunciation, Feast of the. A festival of the Christian church, in commemoration of the announcement of the conception of our Saviour to the Blessed Virgin by the angel Gabriel.—St. Luke i. 26, 38. It is celebrated on March 25, commonly called Lady-day.

ANNUNCIATION, *Order of the.* Founded in Savoy by Amadeus VI., in 1335, as the order of the Collar: received its present name from Charles III. The reigning king of Sardinia (now Italy) is grand-master of the order.

Anobium. The name of a Fabrician genus of Coleopterous insects, characterised by antennæ filiform, the last joints larger; thorax nearly round, not margined, receiving the head; palpi clavate; labium entire.

Anode (Gr. ἄνοδος, *a way up*). The positive pole of a voltaic battery, or the way by which electricity is figured to the mind as entering substances through which it passes; opposed to cathode, the road or way by which it goes out.

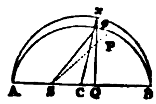
Anodon (Gr. ἀ, priv., ὀδούς, *a tooth*). The name of a genus of Lamellibranchiate Bivalves, including the common freshwater muscle, the shell of which has no articular processes, or *teeth*, at the hinge. The name has also been applied to a genus of serpents, which have the teeth in the mouth very minute, or rudimental: the *Anodon typus* (*Coluber scaber* of Linnæus), a South African species of this genus, lives upon the eggs of birds, which, by the structure of the mouth above-mentioned, it is enabled to swallow entire. The inferior spinous processes of the cervical vertebræ are prolonged into the gullet, and there receive a coating of enamel; thus serving the office of teeth, where the breaking of the egg may take place without the loss of any of its nutritious contents.

Anodyne (Gr. ἀνώδυνος, from ἀ, neg. and ὀδύνη, *pain*). A term applied in Physic to medicines which relieve pain. Anodynes are chiefly of vegetable origin, and generally come under the head of sedatives or narcotics.

Anolis. *Anoli*, *anoalli*, is the vernacular name, in the Antilles, of the lizard to which the generic term *Anolis* is applied. This term is restricted in Zoology to those iguanoid species of lizard which have minute scales on the under part of the last joints of the toes, while the next joints are extended into soft pads transversely striated, but not organised to act as a sucker, as in the geckos. All the species of anolis are natives of the warmer parts of the American continent; all are remarkable for their power of inflating the skin of the throat; they are light and agile in their movements, and in the beauty and brilliancy of their colour exceed all others of the Saurian order.

Anomalistic Year. The interval of time in which the earth completes a revolution with respect to any point in its elliptic orbit. The tropical year is measured by the return of the earth to the same equinox; the sidereal year by its return to the same fixed star; the anomalistic year by its return to the same apsis or extremity of the greater axis of its orbit. The major axis of the diameter of the earth's orbit is not fixed, but has a progressive motion eastward among the stars. Suppose that when the earth is at its perihelion, or point nearest the sun, the other extremity of the major axis points to a given star; when the earth, after having completed a revolution, returns to its perihelion, the diameter will point 11″·8 eastward of the same star; consequently the anomalistic year is longer than the sidereal year by the time which the earth takes to describe 11″·8 of space. It is still longer than the tropical year, for the line of the equinoxes goes backwards at the rate of 50″·1 in a year; therefore after the earth has completed a revolution with respect to the line of the equinoxes, it has still to describe 50″·1 + 11″·8 = 61″·9, before it overtakes the same point of its ellipse. The time occupied in describing this arc is 25 minutes, and the length of the tropical year is 365 d. 5 h. 48 m. 45 s.; therefore the anomalistic year is 365 d. 6 h. 13 m. 45 sec.

Anomaly (Gr. ἀνωμαλία, *unevenness*). A term used in Astronomy to denote the angular distance of a planet from its perihelion, as seen from the sun. There are three different anomalies: the true, the mean, and the eccentric. Let A*p*B be the orbit of a planet, S the sun, AB the transverse diameter, and C the centre. Through *p* draw *p*Q perpendicular to AB, meeting the circle circumscribed about the orbit in *x*. On account of its unequal distances from the sun, the angular motion of a planet in its orbit is irregular: conceive, therefore, that while the real planet moves from A to *p*, another planet moving in the same orbit, with an equable motion, and performing a revolution in the same time, has moved from A to P. This being supposed, the angle AS*p* is the true anomaly; ASP is the mean anomaly; and AC*x* the eccentric anomaly. The mean anomaly is proportioned to the time of description; to find the true anomaly is a problem of considerable difficulty, requiring the aid of the higher mathematics. From the circumstance of its having been first proposed by Kepler, it is usually called Kepler's problem.



Anomaly. In Grammar, an exception from a general rule.

Anomeans (Gr. ἀνόμοιοι). In Ecclesiastical History, the name given to that extreme party among the Arians who denied the similitude of the Son to the Father. (Milman, *History of Christianity*, book iii. ch. v.)

Anomia (Gr. ἀ, neg., νόμος, *law*; because not easily reduced to the ordinary laws of classification). The name of a Linnæan genus of the *Vermes Testacea*, the characters of which, as given in the *Systema Naturæ*, apply to the organisation of the soft parts and shell of the modern *Terebratulæ*. Modern naturalists have limited the term to a genus of acephalous mollusks having two unequal irregular thin valves, of which the flatter one is deeply notched at the cardinal margin. The greatest part of the central muscle traverses this opening to be inserted into a third piece, which is sometimes calcareous, and sometimes simply horny, but which is always attached to foreign bodies. The rest of the muscle serves to join one valve to the other. The animal has a small vestige of a foot, and is remarkable for the length of its labial tentacles. They are attached to oysters and other shells, and frequently acquire the form of the surfaces with which their growing margins are in contact.

Anomodontia (Gr. ἄνομος, *without law*, and ὀδούς, *tooth*). This order of reptiles, of which all the forms have become extinct, is characterised by having teeth wanting, or limited to a single maxillary pair, having the form or proportions of tusks; a foramen parietale; two nostrils; tympanic pedicle fixed; vertebræ biconcave; trunk ribs long and curved, the anterior ones with a bifurcate head; sacrum

of more than two vertebræ; limbs ambulatory. It is composed of the *Dicynodontia* (*Dicynodon*, *Ptychognathus*), and the *Cryptodontia* (*Oudenodon*, *Rhynchosaurus*), and the *Cynodontia* (*Galesaurus*, *Cynochampsa*).

Anona (Menona, the Malayan name of *the custard apple*). A genus of Exogenous trees, representative of the *Anonaceæ*, found in hot latitudes, with large roundish pulpy fruit, which in some species is used as food. The custard apple, so named from its seeds lying in a whitish sweet cream-like pulp, is produced by *A. squamosa*; the cherimoyer, the most esteemed of all the fruits in Peru, is yielded by *A. Cherimolia*; and other kinds are known

Anonaceæ. [ANONA.] An extensive natural order of Exogenous plants, comprehending evergreen trees or shrubs, whose fruit is sometimes eatable, as in *Anona*, most generally dry and aromatic, as in the genera *Unona*, *Habzelia*, &c., whose ripe carpels furnished the *Piper æthiopicum* of the old drug shops. The great mark of *Anonaceæ* is their having ternary (trimerous) polypetalous flowers, and a ruminated albumen.

Anonymous (Gr. ἀνώνυμος, *nameless*, from ἀ, priv., and ὄνομα, *a name*). In Literature, works published without the name of the author. Those published under a false name are termed *Pseudonymous* (ψευδής, *false*). The best catalogue of anonymous works is that of Barbier (*Dictionnaire des Œuvrages Anonymes et Pseudonymes*, 3 vols. Paris, 1822-1824, and now in course of republication); but it is confined solely to French works. There is nothing of the kind in English literature.

Anoplotherium (Gr. ἄνοπλος, *unarmed*, and θηρίον, *beast*). An extinct genus of even-toed Artiodactyle Pachydermata, from the Upper Eocene, characterised by the shortness and feeble size of the canine teeth, which resemble the incisors, and are consequently unfitted for being used as weapons of offence. As the canines in this genus do not project beyond the level of the incisors and molar teeth, no vacant interspace, or *diastema*, is required in the dental series of the opposite jaw for the reception of their pointed extremities, and consequently the series of teeth is uninterrupted in both jaws, a structure observable in no existing animal save man. The Anoplotherium has $\frac{6}{6}$ incisors, $\frac{1-1}{1-1}$ canines, $\frac{4-4}{4-4}$ premolars, and $\frac{3-3}{3-3}$ molars in each jaw. The *Anoplotherium commune* (Cuv.) is about the size of a wild boar, but longer in the body, with the head of an oblong form, and a tail of considerable thickness and as long as the body. Its probable use was to assist the animal in swimming. Another species (*Anoplotherium medium*) is of a size and form more nearly approaching to the light and graceful character of the gazelle. A third species was about the size of a hare. All the species, from the form of the teeth and the absence of claws or horns, appear to have been singularly deficient in defensive organs.

Anorexy (Gr. ἀνορεξία, from ἀ, neg. and ὄρεξις, *appetite*). Loss of appetite.

Anorthite (Gr. ἀ, neg., ὀρθός, *straight*). A lime-Felspar, with the same composition as Scapolite, except that small portions of the lime are replaced by magnesia, potash, and soda. It occurs in white, translucent or transparent crystals, with a vitreous lustre inclining to pearly on the planes of cleavage, principally at Vesuvius, amongst the older lavas of Monte Somma, generally occupying the cavities of chloritic masses. It is also found in Ireland in greenstone-dykes traversing the limestone of Carlingford Mountain, co. Down.

Anorthoscope (Gr. ἀ, neg., ὀρθός, and σκοπέω, *I view*). The name given by M. Plateau of Brussels, to an instrument invented by him, and intended to produce a peculiar kind of anamorphoses by means of two discs rotating rapidly one before the other, the hind one of which is transparent, and bears distorted figures, while the front one is opaque, and pierced with a small number of narrow slits. On revolving the disc the distortions appear as amusing and interesting figures and pictures. As in other toys of a similar kind, the *Phenakistoscope*, for example, the effect depends on the persistence of impressions on the retina.

Anosmia (Gr. ἀ, *without*, and ὀσμή, *smell*). Loss of the sense of smelling.

Anostoma (Gr. ἄνω, *upwards*, and στόμα, *mouth*). A genus of pulmonate or air-breathing Gasteropods, allied to Helix, in which the aperture in the adult is turned upwards towards the spire of the shell, and ringent.

Anourans (Gr. ἀ, priv., and οὐρά, *tail*). A name applied to a tribe of Batrachian reptiles, which lose the tail in arriving at maturity; as the toad and frog.

Anse de Panier. A French phrase applied to arches which are the result of elliptical curves in section; they are the most elegant form of arch used in bridge building.

Anseres (Lat.). In the Linnæan arrangement, the name of the third order of birds, having the bill broad at the top, and covered with a soft skin; the feet webbed. [NATATORES.]

Ant. [FORMICA.]

Ant-eaters. [MYRMECOPHAGÆ.]

Anta. A term used to express the species of pilaster, or pillar, used by the Greeks to terminate the side walls of the temples, such as the temples of Agrigentum, Eleusis, and Rhamnus; they differ from pilasters in this respect, that they are not repeated in the length of an elevation, whereas the pilasters may be repeated as often as the architect desires. The capital of an anta differs also from that of a pilaster, insomuch as the former is a special composition, whilst the latter is but a reproduction, on the flat, of the decorations of the columns themselves. The return faces of the antæ are generally much narrower than the face next the corresponding column; but there is no absolute rule upon this subject.

Antacids. Medicines which neutralise the acid of the stomach.

Antagonistics (Gr. ἀνταγωνιστής). In Anatomy, those muscles are so termed which are opposed to others in their action, as the extensors to the flexors, the pronators to the supinators, the abductors to the adductors, &c.

Antalgic (Gr. ἀντί, *against*, and ἄλγος, *pain*). That which relieves pain.

Antanaclasis (Gr.). In Rhetoric and Composition, a figure in which a word is repeated, but in a different sense or different inflection from the first; which gives a kind of antithetical force to the expression

Labitur, et labetur in omne volubilis ævum.

The return to the former series of thought and diction after the interruption of a parenthesis, is also termed Antanaclasis.

Antaphrodisiacs (Gr. ἀντί, and Ἀφροδίτη, *Venus*). Medicines which quell amorous desires.

Antarctic (Gr. ἀνταρκτικός). Opposite to Arctic. Antarctic circle, one of the small circles of the sphere, parallel to the equator, and distant 23° 27½′ from the South pole. Antarctic pole, the South pole, or southern extremity of the axis of the earth. [Arctic.]

Antarctic Current. This drift current commences on the shores of Victoria land, in the perpetual frost of the south pole. It carries vast quantities of ice and cold water towards the north-east and east, and becomes converted into a coast current, washing and cooling the shores of South America, performing therefore a work nearly the converse of that performed by the Gulf Stream on the shores of Europe. It conveys drift ice to the latitude of about 55°.

Besides the part that is converted into the Peruvian coast current, and runs north, another portion flows more to the south after reaching the coast of Chili, between Concepcion and Valparaiso, reaching Cape Hoorn (or Horn,) and passing into the Cape Hoorn current.

The temperature of the land is so greatly affected by this current that the general mean temperatures of air and ocean in latitude 12° south are reduced the one by 11° and the other by 14°.

Antarctic Ocean. The part of the great ocean within the Antarctic circle is estimated to contain about two millions of square miles, and might with propriety be considered as part of the Pacific Ocean. The land lying within the Antarctic circle is probably of far greater extent and much more elevated than that of the Arctic; but the coast can rarely be approached, the ice being more continuous, and advancing for the most part into much lower latitudes. The climate throughout is excessively severe.

Antecedent. In Analysis, the name given to the first of the two terms composing a ratio. Thus in the ratio $a : b$, a is the antecedent, and b is denominated the consequent.

Antecedent. In Logic, the first member of an hypothetical proposition; followed by the consequent; as in the following instance:—

If we live (*antecedent*),
We live unto God (*consequent*).

Antecedent. In Mathematics, the name given to the first of the two terms composing a ratio. Thus in the ratio $a : b$, a is the antecedent, and b is denominated the consequent.

Antediluvian (Lat. ante, *before*, and diluvium, *deluge*). Anything that existed before the deluge. This term is sometimes used by geologists to designate the period anterior to the presumed Noachian deluge. In this sense it is used chiefly in reference to human history. There is no physical evidence of any single deluge that could have affected the whole surface of the globe during any geological period, and thus the expression is without a literal meaning in geology. It is therefore seldom employed, and when it is, it is meant to refer to the Noachian deluge only.

Ante-fixæ (Lat.). The lions' heads, or other ornaments, which are introduced below the line of the eaves of a temple, through the perforations of which the water is allowed to escape, usually through the mouths, so as not to fall upon the foundations; in this respect it resembled the gargouilles of Gothic architecture. By some writers on architecture this term is used to denote the upright ornaments above the eaves in ancient buildings, which concealed the ends of the harmi, or of the joint tiles, without reference to their function of water-bearers.

Antelope. [Antilope.]

Antenati (Low Lat. *born before*). In English law, a phrase applied to Scots born before the union of the crowns under James I., who were considered aliens in England, while the postnati, born in Scotland after that event, claimed the rights of native subjects of the English crown.

Antenna (Lat.). A moveable, tubular, and jointed sensiferous organ situated on the head, and peculiar to the *Condylope articulata*. Certain Annelides carry soft tentacles or filaments upon the head, which have been termed antennæ; but improperly, according to the above definition, which would restrict the phrase to the jointed antennæ of insects and crustaceans. In the latter class the antennæ are commonly four in number, consisting each of a 'scape,' a 'pedicel' of two joints, and a 'clavolet;' the latter is setaceous, and divided into a vast number of minute joints. It is simple in the external antennæ, but in the internal pair is always composed of two and sometimes of three setaceous filaments. The internal pair of antennæ are situated before or between the eyes, the external behind, at the outer sides of the eyes. In insects the antennæ are always two in number, and situated in the space between or before the eyes; they consequently correspond to the internal antennæ of crustaceans. The cavity or socket in which the base of the antennæ is planted is called the 'torulus,' or bed. The first, and in many cases the most conspicuous, joint of the antennæ is termed the scape. The base of the scape, by which it is articulated with the torulus, is the bulb. It often looks like a distinct joint, and is the point upon which the antenna turns. The

pedicellus, or second joint of the antenna, in some insects, also acts the part of a pivot in the bed of the scape, in order to give a separate motion to the clavola, or clavolet. This, which includes the remaining joints of the antenna taken together, is occasionally terminated by a capitulum or knob; a term applied to the last joints of the clavolet when suddenly larger than the rest. [For the varieties of antennæ with respect to situation, approximation, proportion, direction, figure, termination, and appendages, the reader is referred to the 4th vol. of Kirby and Spence's *Introduction to Entomology*.]

Antennulæ (dim. of antenna). A term sometimes applied to the articulated filaments attached to the jaws or lower lip of Mandibulate insects, and which seem to be endowed with a sensiferous faculty specially adapted to distinguish kinds of food, and applied by the animal to that use: these organs are more commonly called palps, palpi, or feelers.

Antepectus. In Entomology, signifies the under-side or breastplate of the main trunk, and the bed of the first pair of extremities or arms.

Antepenult, or **Antepenultima** (Lat.). In Grammar and Prosody, the last syllable of a word but two.

Antepilani (Lat.). A name given to the two classes of soldiers in the Roman army called Hastati and Principes, as being drawn up (*ante pila*, i.e.) before the Triarii, who were armed with the pilum or long spear.

Anterior (Lat.). In Botany, this is said either when of two lobes of a stigma one, the anterior, is directed towards the front of a flower, and the other, the posterior, towards the back, or in any similar case. It is also applied to certain stipules, which stand between the petiole and stem of a plant, adhering to the former, as in some Cinchonaceous plants.

Antesignani (Lat.). A name given to the class of Roman soldiers called Hastati, as standing in front of the standards (*ante signa*) of the maniples.

Anthelia (Gr. ἀντήλιος, *opposite the sun*). Luminous coloured rings, or glories, observed under certain conditions round the shadow of the spectator's own head. The conditions of the phenomenon are two: first, that the sun be near the horizon, and secondly, that the shadow be projected on a surface covered with dew drops as a field of grass or stubble, or on a dense cloud or fog-bank, distant about 50 or 60 yards. Generally the luminous appearance is very faint, and only one or two rings can be traced; but sometimes, in favourable circumstances, it is strikingly vivid, and two or three small concentric circles appear, surrounded by a much larger one, of whitish light, the head of the observer's shadow being at the common centre. Such brilliant Anthelia were observed by Bouguer and his companions on the clouds of the Andes (*Figure de la Terre*, p. 43), and by Scoresby on the fog-banks in the Arctic seas. Scoresby gives the following dimensions of the rings as measured by him on one occasion: radius of the first or innermost ring 2°; of the second 4° 45′; of the third 6° 30′; and of the outermost 38° 50′. The cause of interior rings is thus explained by Fraunhofer. Light falling directly from the sun on the anterior side of an aqueous globule undergoes a refraction, and a portion of this refracted and consequently coloured light on falling on the interior surface of the opposite side of the globule is reflected back to the eye of the spectator. The large surrounding circle is supposed to be formed by a double reflection, as in the case of the ordinary rainbow. [Halo.]

Anthelix (Gr. from ἀντί, and ἕλιξ, *the helix*, or *external involute margin of the auricle*). In Anatomy, the outer or external ridge of the auricle ear, which runs nearly parallel with the helix.

Anthelmintics (Gr. ἀντί, and ἕλμινς, *a worm*). Medicines which kill intestinal worms, or effect their expulsion.

Anthem (probably the same derivation as Antiphon). In Modern Music, is a term used for any church vocal composition more important than a psalm tune.

Anthemion (Gr.). That ornament or ornamental series used in Greek and Roman decoration, which is derived from floral forms, more especially the honeysuckle, very common in the early period of Greek art. It was much used for antefixes and friezes in architecture, and for interior decoration; also for the painted decoration of fictile vases, and for the borders of dresses. The so-called honeysuckle is alternated generally with some other floral form, as in the excellent examples in the British Museum from the Erechtheium and from the temple of Apollo Epicurius. (Wornum, *Analysis of Ornament*, 1859.)

Anthemis (Gr. from ἄνθος, *a flower*). The chamomile, one of the most useful of our native tonic bitters, belongs to this genus of composite plants. It is the *A. nobilis* of botanists, and is abundant on waste common land, where its prostrate stems form part of the turf. Its stimulant tonic properties make it useful in cases of weak digestion.

Anther (Gr. ἀνθηρά, *a flowery herb*). A hollow case, usually consisting of two parallel cells, and constituting the apparatus that contains the pollen, or male part of a flower. Theoretically considered, an anther is the blade of a leaf, in a contracted state, with its two sides hollowed out and its parenchyma converted into pollen, while the midrib in a fleshy state divides the two lobes, and is called the connective. This part is sometimes highly developed, when the lobes of the anther are often placed at a distance from each other, as in *Nymphæa*; or it is altogether absorbed, when the lobes run together, and there is but one cell, as in *Epacris*. Other modifications produce other striking appearances: one lobe, for instance, disappears, and the connective is expanded into the state of a petal, as in *Canna*; or it is simply lengthened and distorted, as in *Salvia*; or, the anther remaining in its normal

state, it is converted into a fleshy mass, as in *Rosa*; and it undergoes many similar transformations, either from the same or other causes. What is most curious about the anther is its property of opening to discharge its pollen just at the very time when the stigma is ready to receive the influence of the latter. The cause of this sympathy between two really independent parts is supposed to consist in an emptying and drying up of the cellules forming the lining of the anther by the absorbent action of the ovary, which, it is imagined, by its own efforts thus brings about an action which is necessary to its own complete operation. The cellules lining the anther, when thus dried up, contract, and pull against certain fissures or dehiscent lines in the valves of the anther, which give way, and so form openings by which the pollen escapes; or heat is evolved and the cases are thus burst.

Anthesis (Gr. ἄνθησις). The period when flowers expand. It is at that time that all the curious phenomena of fertilisation occur, and the parts are all in their most perfect state.

Anthodium (Gr. ἀνθώδης, *full of flowers*). The head of flowers of a thistle or daisy or other composite plant; it is the same thing as capitule, and is applicable to all cases where a number of small flowers or florets are combined in a head, and surrounded by a common involucre. An anthodium is nothing but a depressed spike.

Anthology (Gr. ἀνθολογία, *a collection of flowers*). In ancient Literature metaphorically applied to a collection of short pieces of poetry on amatory, convivial, moral, funereal, &c., subjects. The first collection known by the name of Anthology was made by Meleager, a Syrian Greek poet, who lived about a century before the birth of Christ; to this additions were made by different hands as low down as the times of the Byzantine empire, and it has been several times edited by modern scholars.

Antholysis (Gr. ἄνθος, *a flower*, and λύσις, *a breaking up*). The changes of flowers from their usual to some other state, as leaves, branches, &c.

Anthophorum (Gr. ἀνθοφόρος, *bearing flowers*). A columnar process arising from the bottom of the calyx, and having at its apex the petals, stamens, and pistil. It is usually very short, and is in reality an internode between the whorls of sepals and petals.

Anthophyllite (Gr. ἄνθος, and φύλλον, *a leaf*). A kind of Tremolite occurring in masses of acicular fibres, of a grey or clove-brown colour, with an occasional blue tinge and a glistening pearly lustre. It is found in Norway, Greenland, and Connecticut.

Anthosiderite (Gr. ἄνθος, and σίδηρος, *iron*). A hydrated silicate of iron occurring in fine fibrous tufts, with a radiated structure and of an ochreous-yellow and yellowish-brown colour, at Antonia Pereira in Minas Geraes in Brazil, associated with Magnetite.

Anthoxanthum (Gr. ἄνθος, and ξανθός, *yellow*). A dwarf annual grass, found plentifully in pastures, and having sweet-scented leaves, the scent depending on the presence of coumarin. There is no doubt the fragrance of hay is owing to its presence. The flowers are in oval heads, which become dull yellow when ripe. Farmers call it the sweet vernal grass.

Anthozasia (Gr. ἄνθος, and ζάω, *I live*). When the leaves of a plant assume the appearance of petals.

Anthozoa (Gr. ἄνθος, and ζῶον, *animal*). The class of Corals, and Actiniæ, also termed Actinozoa. They are divisible into the following families: —

Family Actiniidæ.
" Zoanthidæ.
" Xeniidæ.
" Alcyonidæ.
" Pennatulidæ.
" Tubiporidæ.
" Caryophyllidæ.
" Gorgoniadæ.

Anthracin. A solid crystalline hydrocarbon, accompanying naphthalin in the distillation of coal tar.

Anthracite (Gr. ἄνθραξ, *charcoal* or *coal*). A variety of coal containing, when pure, hardly any volatile ingredients, and in some cases consisting almost exclusively of carbon. Very large quantities of anthracite occur in the coal fields of South Wales, and much larger deposits exist in North America.

Anthracite burns with intense heat and very slowly, but it requires a peculiar structure of the furnace to allow it to be used economically. It requires a strong draught, and the carbonic oxide formed during combustion does not, without special arrangement, circulate in long tongues of flame, such as are used to get up steam rapidly. Hence it was long after other coals were in common use that anthracite was rendered available for steam power. It is now used both for ordinary furnace purposes, and in the manufacture of iron, and is a very valuable fuel.

In Pennsylvania, in North America, is a very remarkable series of anthracite beds, extending over a quarter of a million of acres of ground. There are here sixteen workable seams, the thickest being as much as thirty feet. Other deposits of smaller magnitude occur elsewhere, but there are none containing such thick masses or so many beds.

Anthraconite. [Stinkstone.]

Anthracotherium (Gr. ἄνθραξ, *charcoal*, and θηρίον, *a beast*). A name indicative of the stratum in which the fossil genus of Pachyderms, to which it is applied, was found, viz. in the tertiary Miocene coal or lignite of Cadibona, in Liguria. The genus presents seven species, some of them approximating to the size and character of the hog; others approaching nearly to the dimensions of a hippopotamus.

Anthranilic Acid. A solid crystalline body derived from indigo.

Anthrax (Gr). The name of a Fabrician

genus of Dipterous insects, having the mouth provided with a very long straight setaceous sucker formed of two unequal horizontal valves, and containing setaceous stings; palpi two, hairy; antennæ distant, the last joint setaceous. The genus is now raised to the rank of a family, *Anthracidæ*, characterised by a short body; wings spreading widely out; antennæ distant, two and sometimes three-jointed; the head as high as the thorax. Two of the genera (*Somatia* and *Anthrax* proper) are British.

ANTHRAX. A carbuncle. A hard circumscribed tumour, resembling in colour a glowing coal.

Anthrenus. The name of a Linnæan genus of Coleopterous insects, having the antennæ clavate, the club solid; palpi unequal, filiform; maxillæ membranaceous, linear, bifid; labium entire; head hid under the thorax.

Anthribus. The name of a Fabrician genus of Coleopterous insects, applied to that section of the Linnæan *Curculiones* which has the lip bifid, the jaw bifid and short, and the proboscis short.

Anthropology (Gr. ἄνθρωπος, *a man*, and λόγος, *a science*). The science of Man and Mankind; subordinated under three great heads: *Ethnology*, or the study of the races of men; *Archæology*, or the study of the past evidences of man's existence; and *Ethnography*, or the study of man's works.

Anthropomorphites (Gr. ἄνθρωπος, and μορφή, *form*). Persons who conceive the Deity to have naturally the human shape. Such sensuous conceptions of the nature of God have been always common among heathens.

Anthropophagi (Gr. ἀνθρωποφάγος). People who feed upon human flesh.

Anthurus (Gr. ἄνθος, *a flower*, and οὐρά, *a tail*). A spike of minute flowers arranged closely on a long axis, as in the genus *Piper*.

Anthus. The name of a subgenus of Passerine birds, including the pipits.

Anti (Gr. *against*). This Greek preposition is constantly used as a prefix to express opposition; thus, antidote, antibilious, antipathy, &c.

Antiar. [UPAS.] A Javanese poison.

Antiarine. The poisonous principle contained in the milky juice of the *Antiaris Toxicaria*, a large forest tree growing in Java. This poison acts upon the brain and spinal marrow, and paralyses the heart.

Antiaris (Jav. antja). The upas tree of Java belongs to this genus of *Artocarpaceæ*. The tree, which attains considerable size, secretes a milky juice which contains a most virulent poison, the antjar poison of Java, though extremely exaggerated statements have been made respecting its influence on animal life. It was said to grow in a desert with no other vegetation within miles of it, and to destroy all living creatures which approached it; but it is now known to grow in woods amongst other trees, and birds and lizards have been observed on its branches. It is, however, a very dangerous poison, and severe effects have been felt by persons merely climbing the trees: the dried juice, moreover, is most venomous.

Anti-attrition. A compound applied to machinery to prevent the effects of friction. It frequently consists of a mixture of plumbago with some greasy material.

Antibrachium (Gr. ἀντί, and βραχίων, *arm*). The fore-arm, or third segment of the anterior extremities, which is formed, in the skeleton, by the radius and ulna conjointly; or sometimes by the radius, either alone, or with the ulna partially developed. And the forearm articulates, above with the arm, below with the hand.

Anticardium (Gr. ἀντί, and καρδία, *the heart*). In Anatomy, the cavity under the breast, which is just against the heart, and is called the pit of the stomach.

Antichlor. Sulphite of Soda is so called, because used in removing the last traces of chlorine from bleached paper pulp.

Antichrist (Gr. ἀντίχριστος). Mentioned by St. John, 1st Ep. ii. 18, and supposed to be the same with the 'man of sin' whose coming is foretold by St. Paul, 2 Thess. ch. ii. The speculations in which theological writers have indulged respecting this great adversary of Christianity have been various and most fanciful. At the council of Gap, in 1603, the reformed ministers there assembled, inserted an article in their Confession of Faith, in which the pope is pronounced Antichrist. Grotius, and most catholic divines, consider Antichrist as symbolical of Pagan Rome and her persecutions; Leclerc, Lightfoot, and others, find in the term a symbol of the Jewish Sanhedrim, or of particular Jewish impostors.

Antichthon (Gr). In Greek astronomy, an imaginary world, in the scheme of the Pythagoræan Philolaüs. It is a body distinct from the earth, and nearer to the central fire. Aristotle ascribes the idea of the Antichthon to the Pythagoræan doctrine of the properties and virtues of numbers. (Sir G. C. Lewis, *Astronomy of the Ancients*, ch. ii. sect. 17.)

Anticlimax. In Architecture, an anticlimax is said to have been attained, when the original composition is succeeded by a motive of the same character, but upon a much diminished scale to that of the principal member of the series. Thus, the domes of Somerset House, and of the National Gallery, may be cited as illustrating the precise relations of an 'anticlimax' to the primary motive of the composition of those buildings.

ANTICLIMAX (Gr. ἀντί, and κλῖμαξ, *gradation*). In Rhetoric, when a sentence or discourse, instead of ascending from little to great, descends from great to little. Horace has given a famous example,

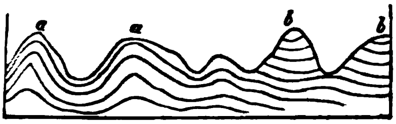
Parturiunt montes, nascetur ridiculus mus.

There are also several striking examples of this figure in Pope, as in the verse,

Die, and endow a college or a cat.

Anticlinal Axis (Gr. ἀντί, and κλίνειν, *to incline*). If a range of hills or a valley

be composed of strata which, on the two sides, dip in opposite directions, the imaginary line that lies between them, towards which the strata on each side rise, is called the anticlinal axis. In a row of houses with steep roofs facing the south, the slates represent inclined strata dipping north and south, and the ridge is an east and west anticlinal axis (Lyell). In the annexed diagram, *a a* are the anticlinal, and *b b* the synclinal lines.



Anticlinal and Synclinal Line. In Geology, the imaginary line from either side of which strata are seen to dip in opposite directions. It is not uncommon, in cases where strata have been disturbed from their original horizontality, to find some parts of a series of strata in a ridge or saddle-shaped position, having been apparently lifted by a linear upheaving force. The line of this force is called an Axis of Elevation, and if two such are parallel, the beds between will occupy the position of two ridges and a furrow. The ridge is an *anticlinal*, and the furrow a *synclinal* axis. Excellent examples of anticlinals are seen in the Jura mountains, where the mountain chain lies in the direction of the axes of this kind. The phenomena are also common in the western parts of England, throughout the country from north to south. An inverted V (Λ) represents a transverse section of a bed raised by an anticlinal; but the angle has often been broken away and rounded, thus giving the saddle-shape. The V in its usual position represents a bed bent by a synclinal. Saddle and trough are terms sometimes used instead of anticlinal and synclinal. The result of an anticlinal is not unfrequently a 'Valley of Elevation' [which see]. Synclinals are often hardly indicated at the surface; but they sometimes produce natural valleys, either alone or in systems of several parallel to each other, separated by anticlinal ridges.

Anticous. In Botany, is applied to an anther whose lobes are placed facing the style; or to a petal which is stationed on that side of a flower which is next the eye of an observer as it grows upon its stem.

Antifriction. Any arrangement of machinery by which the resistance to motion by friction is opposed is called 'antifriction.' This term is especially applied to a description of alloy destined for this purpose, composed of bell metal, or aluminium bronze, both of which enjoy the faculty of opposing the least resistance to motion of any possible varieties of metal in union with the greatest resistance to the effects of friction, as far as regards the wearing away of the surfaces of contact.

Antigorite. A species of Serpentine in which a portion of the silica is replaced by alumina; lustre weak; feel smooth but not greasy. It is found in the Antigoria Valley, in Piedmont.

Antiguggler. A siphon, so inserted into casks or carboys as to admit air over the liquor contained in them, and to allow of its being poured out without agitation.

Antilegomena (Gr. *things spoken against*). In Theology, a term applied to those books of the New Testament concerning the authority of which there were disputes in the church, although they were ultimately received into the canon; namely, the Second Epistle of Peter, those of James and Jude, that to the Hebrews, the Second and Third of St. John; and the Apocalypse.

Antilogarithm. In its most common acceptation, denotes the number to a logarithm. Thus, in the common system of logarithms, 100 is the antilogarithm of 2, because 2 is the logarithm of 100. Sometimes the term is used to denote the complement of the logarithm, or the difference of the logarithm from the next higher term in the series, 1, 10, 100, &c.

According to the notation of inverse functions the antilogarithm of x would be represented by $\log^{-1}x$; thus $\log^{-1}2 = 100$.

Antiloimic (Gr. ἀντί, and λοιμός, *pestilence*). Remedies used in the prevention and cure of the plague.

Antilope. Antelope: a term which, according to Cuvier, is a corruption of the word 'antholops,' applied by Eustathius, an ancient naturalist, to the gazelle, in allusion to its beautiful eyes. The name is now given to a division of the hollow-horned Ruminants [Cavicornia], in which the bony axis of the horn is without cavities or sinuses. Antilopes are further distinguished by suborbital or maxillary glandular pouches, and their light and elegant figure. They are the natives, for the most part, of the wildest and least accessible places in the warmer latitudes of the globe; frequenting the cliffs and ledges of mountain rocks, or the verdure-clad banks of tropical streams, or the oases of the desert. They traverse the intervening wildernesses in pairs or in troops with incredible fleetness, clearing obstacles, which would impede the course of other quadrupeds, by a succession of agile bounds.

The antelopes are now arranged under a number of subgeneric divisions, according to the form of the horns, which are peculiar to the male. Forty-seven species are known, which, with one or two exceptions, are peculiar to the Old World.

Antimonial Copper. Native sulphide of copper and antimony. [Wolfsbergite.]

Antimonial Copper Glance. [Wolchite].

Antimonial Nickel. [Ullmannite.]

Antimonial Ochre. The name given to a hydrated antimonious acid, which occurs in earthy masses and as a pulverulent crust. [Cervantite.]

Antimonial Silver. [Discrasite.]

Antimonic Acid. The peroxide of antimony. [Antimony.]

Antimonite. A mineralogical synonym for native sulphide of antimony or grey antimony ore. [STIBNITE.]

Antimony. A brittle metal of a silver white colour; specific gravity, 6·7. Fuses at 810°, or just at a red heat. The principal properties of this metal were first described in the *Currus Triumphalis Antimonii* of Basil Valentine, published towards the end of the thirteenth century. When heated in an open vessel, it gradually combines with oxygen, and evaporates in a white vapour. There are three oxides of antimony. The protoxide consists of 65 antimony + 12 oxygen: it is a greyish white powder, eminently purgative, sudorific, and emetic; and as such, of much importance in medicine. It is the active base of emetic tartar and of James's powder. The other oxides of antimony, from combining with certain bases, have been called antimonious and antimonic acid; they consist respectively of 65 antimony + 16 oxygen, and 65 + 20. The combination of chlorine and antimony was known to the old chemists under the name of *butter of antimony*. The principal ore of antimony is the *sulphuret*: it is met with in commerce, melted into conical ingots, under the name of crude antimony. It is of a bluish grey colour, metallic lustre, and a striated texture; specific gravity 4·62; it is much more easily fusible than the pure metal. Antimony forms brittle alloys with some of the most malleable metals: when gold is alloyed with a two-hundredth part of antimony, the compound is brittle; and even the fumes of antimony in the vicinity of melted gold are sufficient to render it brittle. Alloyed with lead in the proportion of 1 to 16, and a small addition of copper, it forms the metal used for printers' types: with lead only, a white and rather brittle compound is formed, used for the plates upon which music is engraved. With iron it forms a hard whitish alloy, formerly called *martial regulus*: 12 parts of tin and 1 of antimony form hard pewter. The white metal spoons and teapots are formed of an alloy of 100 tin, 8 antimony, 2 bismuth, and 2 copper.

Antimony is the stimmi, or stibium, of the old chemists.

Antinomians (Gr. ἀντί, and νόμος, *law*). Oppugners of the law. In Theology, Antinomians are such as interpret the law, to which St. Paul refers more especially in the Epistle to the Romans, as including all moral ordinances whatsoever; and push the contrast which the Apostle maintains between faith and the works of the law to an extreme extent, asserting the entire uselessness of good works in any case, and the sole efficacy of faith. Hence the term Solifidian is applied to the same class of religionists. The name of Antinomian was first given by Luther, as a term of reproach, to the followers of the opinions of John Agricola on this subject, who complained, however, that his notions had been unfairly represented. Similar doctrines appear to have been held in England by an ephemeral sect in the time of the commonwealth: but the word Antinomianism may now be taken rather as expressing the extreme to which the Calvinistic scheme of theology has the tendency to lead men, than as denoting the creed of any distinct sect or congregation, either in this country or abroad.

Antipaedobaptists. In Theology, those who object to the baptism of infants on the ground that they are not capable of understanding the nature of the rite, and of pledging themselves to such a course of life as is required of all such as come to be baptized. [BAPTISTS.]

Antiparallel or **Subcontrary.** In Geometry two pairs of right lines in the same plane are said to be *antiparallel* or *subcontrary* when equal and opposite quantities of turning applied to the lines of either pair bring them into coincidence with the other pair. For instance, the two pairs of opposite sides of a quadrilateral inscribed in a circle are antiparallel.

Two circular sections of a quadric cone whose planes intersect are also sometimes called antiparallel or subcontrary.

Antipathes. A genus of Corticiferous Polypes, or corals, in which the central axis is enveloped by so soft a cortex that it falls off when the specimen is removed from the water. From the colour of the axis, it is commonly called 'black coral.'

Antipathia (Gr. ἀντιπάθεια). The *antipathic method* in Medicine, consists in the use of remedies which produce effects of an opposite nature to the symptoms of the disease: the maxim adopted is '*contraria contrariis opponenda.*' Hippocrates may be regarded as the founder of this doctrine.

Antipedes (Lat. ante, *before*, pes, *foot*). In Zoology, the anterior or pectoral extremities, formed by the diverging appendages of the occipital segment of the skull.

Antipelargia (Gr. ἀντί, and πελαργός, *a stork*). The *Lex ciconiaria*, an old law by which children were compelled to nourish their aged parents. The Ciconia, or stork, is famous for the care it takes of its parents, and hence the Latin name.

Antiperistaltic (Gr. ἀντί, and περιστέλλω, *I wrap up*). That movement of the intestinal tube which is retrograde or contrary to the proper course impressed upon the contents by the ordinary vermicular or peristaltic action.

Antiphlogistic Treatment (Gr. ἀντί, and φλόγωσις, *inflammation*). In Surgery, the means of removing or lessening inflammation, and of obviating its effects.

Antiphon (Gr. ἀντίφωνος). A piece of music performed in cathedral service by choristers who sing alternately. This manner of singing is very ancient in the church; some suppose it to have descended from the practice of the earliest Christians, who, according to Pliny, were accustomed to sing their Hymn to Christ in parts or by turns (*secum invicem*). The antiphon, in ancient church music, is the short verse sung before the psalms and other portions of the service.

Antipodes (Gr. ἀντί, and πούς, *the foot*).

Denotes, literally, those who stand feet to feet; that is, the inhabitants of opposite parts of the earth. They live under the same parallels of latitude, on opposite sides of the equator; consequently the seasons are reversed, i.e. when it is summer to the one, it is winter to the other. Their longitude differs by 180°, or 12 hours; consequently their days and nights are reversed; that is, when it is mid-day to the one, it is midnight to the other. They have the same climate; in so far, at least, as climate depends on latitude.

Antipope. One that assumes the title and functions of pope without a valid election. The term more particularly refers to the popes who maintained themselves in opposition to each other during part of the fourteenth and fifteenth centuries. The great western schism was caused by the rival jealousies of the French and Italian parties in the conclave; the French cardinals having been accustomed by their numbers and the influence of the kings of France, to carry the election in favour of French candidates, while the popes resided at Avignon, a period of about 70 years from 1305 to 1376. Accordingly, when the Italian party at last succeeded in the election of Urban VI., in 1389, the French cardinals retired from Rome, and there invested with the functions of pope one of their own body, under the title of Clement VII. They attempted, in the first instance, to maintain themselves in Italy, and war was proclaimed between the two rivals. After a short struggle, Clement retreated to Avignon, and there he, and his successor, Benedict XIII., held their court; while Urban, and after him Boniface IX. and Gregory XII., reigned at Rome. They were supported respectively by different European states, of which France, Austria, Castile, Aragon, Savoy, Genoa, and Scotland sided with the party of the seceders. The schism caused great scandal throughout Christendom, and measures were repeatedly taken, and baffled only by the artifices of the rival claimants, for an adjustment of the difference. However, in 1409, the rival parties were both declared by the Council of Pisa guilty of heresy and schism, and thereby the validity of both claims greatly disproved. Alexander V. was then elected in due form; and the antipopes were unable long to maintain their pretensions against the authority of a general council.

Antiquary. Copiers of old books, especially in convents, were termed *Antiquarii* in the Latin of the middle ages. In modern phraseology, antiquary is defined 'a person who studies and searches after monuments and remains of antiquity, as old medals, books, statues, inscriptions, &c.;' to which may be added those who make the manners and customs of ancient times an especial subject of inquiry. Henry VIII. gave Leland the title of his 'Antiquary.' The Royal Society of Antiquaries, in London, was founded under the reign of George II. [ACADEMY.]

Antique. The term especially employed to convey the meaning of an ancient or of a very early monument. There are as many interpretations as to the meanings of the word as there are sentiments with regard to antiquity, and the word 'antique' has therefore been applied in a countless variety of manners. The general acceptation of the word is, however, understood to be that of a period antecedent to the revival of the classical studies in Western Europe, or before the *risorgimento,* or *renaissance,* of the arts from their assumed period of lethargy. There was, in fact, a distinct character about the productions of the artists of the more ancient and the more modern times, which was sufficiently marked to produce in the best of them a separate style of art, and which has led to the establishment of the schools of the so-called antique and modern styles; the mediæval arts form as it were an intermediate class, which was as distinctly marked as any of the other styles. The antique school was distinguished by an anthropomorphism and a divination of the human form; the mediæval school was formed upon, and characterised by, a species of contempt for the human figure, and an aspiration after an ideal perfection, and therefore there is something vague and undefined in its efforts to represent the objects it copied; whilst the modern school has united the indefiniteness of its aim with that clearness of the perception of its objects, which is so marked a characteristic of its productions. The antique schools date from the dawn of civilisation to the end of the tenth century; the mediæval schools date from the tenth to the fifteenth centuries; and the modern schools have continued the traditions of the masters of art to the present times. The works of the various authors are respectively known by the names of their actual schools, and are called antique, mediæval, or modern, as they belong either to the one or the other of them.

Antiquities. Under this term, which has not a very definite meaning in modern European languages, we appear generally to comprehend all memorable things respecting Man in his social state in past time, except the political events, which form more properly the subject of History. Thus, manners and customs, language, literature, topographical details, the monuments of architecture, sculpture, &c., of ancient times, all fall under the general cognisance of the antiquary. His science is, as it were, subsidiary to the more general objects of the historian. In a more restricted sense, the study of antiquities is confined to the description and interpretation of the existing relics of former times, such as architectural remains, manuscripts, medals, and other objects of curious research. Among classical writers, there is, perhaps, only one who falls exactly within the definition of what in modern times we should term an antiquary; viz. Pausanias, whose work, written about the period of Marcus Antoninus, is entirely devoted to a description of the monuments of earlier periods then existing in Greece. But about the time of the revival of letters, when the study of classical

writers became the main pursuit of literary men, classical antiquities became also a distinct and important branch of research. Besides the writers who employed their antiquarian knowledge in the shape of commentary on classical authors, a great number devoted their talents to the production of treatises exclusively illustrating particular points in ancient customs and usages. The following older works may be named as among the most comprehensive and general which we possess, containing an immense repository of facts, which the more refined criticism of modern times has sifted and applied with better success: the treatises of *Signonius* and *Meursius*—the latter chiefly on Greek antiquities—collected in twelve folio volumes, Florence, 1741: the vast *Thesaurus Antiquitatum Græcarum* of the Dutch commentator Grævius (Leyden, 12 vols. fol. 1697, &c.); and the still more extensive work of Gronovius (*Thesaurus Antiquitatum Romanarum*, Leyden, 13 vols. fol. 1697), together with its continuations and supplements, by Burmannus, extending in the whole to 45 volumes; the works of Polenus, Pitiscus, and Gruterus, on the same plan with those two vast collections; the *Antiquité Expliquée* of Bernard de Montfaucon, extending, with the supplements, to 15 vols. folio, Paris, 1719–24. From these great works our modern Compendia in common use are chiefly compiled. The names of Boeck (*Public and Private Economy of Athens*), Heeren (*History of Ancient Commerce, &c.*), Müller, Niebuhr, Creuzer, Böttiger, Wachsmuth, &c., attest the equal industry and superior critical skill of the classical antiquaries of modern Germany, the country in which this branch of knowledge is most successfully cultivated; while in England many distinguished scholars, such as Arnold, Grote, and Sir George Lewis, have followed the same or a similar path. Dr. Smith's valuable series of Dictionaries may now be referred to as comprising the results, well sifted, of earlier diligence in this great study. In that more restricted branch of classical antiquities, the description of the monuments of ancient art, among many illustrious names we may mention those of Caylus (*Recueil d'Antiquités Egyptiennes, Grecques, et Romaines*, 7 vols. 4to. Paris, 1752, &c.) and the Abbé Winkelmann. In the peculiar study of Egyptian antiquities, the names of Young, Hamilton, Champollion, Bunsen, and Sharpe, stand pre-eminent. In ecclesiastical antiquities, the huge collections of Ugolinus (*Thesaurus Antiquitatum Sacrarum*, 34 t. fol. Antv. 1744) and Canisius (*Lectiones Antiquæ*, edited by Basnage, 4 t. fol. v. Antv. 1725) may be mentioned among many others. Lastly, the antiquities of the middle ages have received much and accurate attention, especially in France and England, within the last century. Besides the works of Leland and Camden, the fathers of English antiquities, of Dugdale and Hearne, &c., we may name in modern times, Fosbrooke (*British Monachism*, 2 vols. 4to. 1802, and *Encyclopædia of Antiquities*), Strutt (*Regal and Ecclesiastical Antiquities of England*, 4to. 1773, and many subsequent works), Brand, Lodge, Playfair, &c. &c., besides many who have devoted themselves to particular branches of the subject; and, among later authors, Sir Henry Ellis, Sir F. Palgrave, Sir H. Nicolas, Mr. Petre, W. Wright, &c. In French antiquities, the greatest name is that of Montfaucon (*Monumens de la Monarchie Française*, 5 vols. fol. Paris, 1725, &c.); while the Italians, among whom the study of national antiquities has been very sedulously cultivated, are peculiarly indebted to the indefatigable Muratori. His principal works are the *Antiquitates Italicæ Medii Ævi*, and *Rerum Italicarum Scriptores*: the whole are said to amount to 41 vols. in folio, besides 34 in 8vo.

Antirrhineæ. A small division of Scrophulariaceous plants, consisting of *Antirrhinum* (the snap-dragon of the gardens), *Linaria*, and a few other genera.

Antiscii, or **Antiscians** (Gr. ἀντί, and σκιά, *shadow*). An old term used in Geography to denote those inhabitants of the earth whose shadows fall in opposite directions. The inhabitants of the north and south temperate zones are always Antiscians; those living within the tropics may be Antiscians at one season of the year, and not at another.

Antiscorbutics (Gr. ἀντί, and scorbutus (a barbarous Latin word), *scurvy*. Medicines against the scurvy.

Antiseptic (Gr. ἀντί, and σήπειν, *to putrefy*). Antiputrefactive. Substances which prevent or check the putrefaction and decay of animal and vegetable matter, are called antiseptic.

Antispasmodics (Gr. ἀντί, and σπασμός, *a spasm*). Medicines which alleviate or cure cramp and spasm.

Antistrophe. [STROPHE.]

Antithesis (Gr.). In Rhetoric, a figure in which two thoughts, words, or sentences are set in opposition to each other, in order to be more strikingly brought forward by the contrast; as in the following sentence from Cicero: 'Quod scis, nihil prodest: quod nescis, multum obest.' 'Your knowledge avails you nothing: your ignorance hurts you much.' Quintilian translates the Greek word ἀντίθεσις by the Latin *contrapositum*.

Antitragus. In Anatomy, the process of the external ear opposite the tragus, and behind the *meatus auditorius*, or ear-passage.

Antitropal (Gr. ἀντί, and τρέπειν, *to turn*). When in a seed the radicle of the embryo is turned to the end farthest away from the hilum. This, although a comparatively unusual position of parts, is nevertheless the normal position, if the exact nature of the developement of an ovule is rightly understood.

Antitype (Gr. ἀντίτυπος). Literally, a copy, answering to the type which determines its character. In Theology the term denotes the person in whom any prophetic type is regarded as fulfilled. Thus if Moses guiding the Israelites to the promised land, be considered

as a type, Christ is the antitype as guiding the redeemed to their rest in heaven. In this sense the type is always inferior to the antitype.

Antlia (Gr.). The oral instrument of Lepidopterous insects, in which the ordinary trophi, or instruments for obtaining, are replaced by a spiral, bipartite, tubular machine for suction, with its appendages. It principally consists of the solenaria, or two lateral subcylindrical tubes, and the fistula, or intermediate subquadrangular pipe, formed by the union of the two solenaria, which intermediate canal conveys the nectar to the pharynx. Theoretically and morphologically the solenaria are the maxillæ inordinately elongated, which support at their bases two minute palpi. Rudiments of the upper lip or labrum, and mandibles, exist above the maxillæ; and below these is the labrum, attached to the head, and distinguished by a pair of large palpi.

Antlia Pneumatica. A constellation of the southern hemisphere, from its supposed resemblance to an air-pump.

Antœci (Gr. ἀντί, and οἶκος, *a house*). Those who live over against each other; a term used in Geography to denote the inhabitants of the globe who live under the same meridian, but on opposite parallels of latitude. The hours of the day or night are the same to each, but the seasons of the year are opposite; that is, when it is summer with the one, it is winter with the other.

Antoninus, Itinerary of. An exceedingly valuable geographical work, extending over the whole Roman empire, and containing the distances on all the Italian and provincial roads, as well as from port to port. The date and author of the work are unknown.

Antoninus, Wall of. A turf entrenchment, raised by the Romans across the north of Britain, under the direction of Lollius Urbicus, legate of Antoninus Pius, about A.D. 140, and is supposed to have connected a line of forts erected by Agricola in A.D. 80. It extended from Dunglass Castle, on the Clyde, to Caer Ridden Kirk, near the Frith of Forth; and included a rampart and ditch, with nineteen forts, the mean distance between each fort being rather more than 2 English miles.

Antonomasia (Gr. from ἀντί, *instead of*, and ὄνομα, *a name*). In Rhetoric and Composition, a figure by which a proper name is put for an appellative noun; as where a tyrant is called a Nero, an usurper a Cromwell, &c.: or, vice versâ, a complimentary periphrasis, or an appellation derived from some attribute, is put for a proper name; as where a king is called 'His Majesty,' or Tacitus 'the prince of political historians.'

Antozone. A name proposed by Schönbein to distinguish a peculiar condition of ozone. [OZONE.]

Antozonite. A name given by Schönbein to a fetid variety of Fluor Spar found at Wölsendorf, in the Palatinate.

Antrimolite. A variety of Mesolite, occurring in white, silky and fibrous stalactites, in amygdaloid, at Ballintoy, on the north coast of Antrim, in Ireland.

Antrum (Lat.). A cavity in the superior maxillary bone. It is frequently termed *antrum Highmorianum*, from the name of its discoverer, the eminent surgeon, Highmore.

Antrustions; otherwise styled Fideles (Faithful) and Leudes (Leute, Germ. *people*). A class of people among the Franks, who were the personal vassals or dependents of the kings and counts. They were not dependent on them by reason of holding lands by their grant, but rather, in consequence of being such dependents, were favoured with donations of land, or benefices; which, in process of time, becoming hereditary, assumed the character of fiefs. [FEUDAL SYSTEM.] The original word from which antrustion is derived was undoubtedly the same with that from which our word *trust*, confidence, has its descent.

Anubis. In Mythology, an Egyptian deity, identified by the Greeks with Hermes. In Egyptian painting and sculpture he is represented as a man with the head of a dog, whence Virgil (Æneid, viii. 698) speaks of Anubis as *latrator*.

Anus. The excrementary orifice of the alimentary canal, which sometimes opens directly on the exterior surface of the animal, as in most Mammals; sometimes into a cavity common to it with the outlets of the urinary and genital organs, called the cloaca, as in most oviparous Vertebrates; sometimes into the respiratory cavity, as in most Mollusks. In Entomology, it signifies the two last segments of the abdomen, and includes the podex, hypopygium, culus, ovipositor, and appendices. In most of the Acrites there is but one orifice to the alimentary cavity, which thus combines the functions of mouth and anus.

Anvil (Anglo-Sax. anfilt). A mass of iron on which a smith works the piece of iron he is operating upon. The generality of anvils are made with a square block of iron in the centre, to which a strong projecting and pointed piece of steel, called the beak iron, is welded; the quarter, with a hole for various tools, and the feet are attached: the whole of the smooth face on the top is formed of steel. At the present day, the whole of the upper part of an anvil is worked out of one piece of wrought iron, and the lower part, or the feet, is of another; and the best anvils are made to incline inwards from the outer face on both sides, in order to resist the tendency of the iron to spread laterally under the series of blows it receives.

Aorist (Gr. ἀόριστος, *indefinite*). In Grammar, that inflexion of the verb which leaves the time of the action denoted uncertain.

Aorta (Gr. ἀορτή). The great arterial trunk which issues from the left ventricle of the heart. After death it is found empty. It is single in Mammals and Birds; double in most Reptiles, and in the Cephalopods; triple in the Crustaceans.

Apagynous (Gr. ἅπαξ, *once*, and γυνή, *a female*). When a plant fructifies but once, perishing immediately after it flowers. It is the same as monocarpic, and nearly the same as annual; only that, like the latter term, it includes such plants as the American agave, which live many years before they fructify.

Apalus. A Linnæan genus of Coleopterous insects, having the antennæ filiform; the palpi equal and filiform; the maxillæ horny and one-toothed; the labium membranaceous, truncate, and entire.

Apanage or **Appanage** (Low Lat. appanagium, *an allowance for bread*, i.e. panis). In the Feudal Law, an allowance to younger branches of a sovereign house out of the revenues of the country; generally together with a grant of public domains. A district with the right of ruling it, when thus conferred, is termed *paragium*. An apanage, in ordinary cases, descends to the children of the prince who enjoys it.

Apatelite. A mineral resembling Copiapite, found in small friable nodules of a clear yellow colour, disseminated in an argillaceous bed at Meudon and Auteuil, in France.

Apatite (Gr. ἀπατάω, *I deceive*; from the fallacious resemblance it bears to other minerals). Native Phosphate of Lime. When crystallized it occurs in six-sided prisms, usually of a green or greenish colour. The amorphous varieties are used for manure, and the massive kinds found in Spain, at Logrosan in Estremadura, furnish a building-stone. Apatite usually occurs in crystalline rocks, but it is also found in granular limestone and sometimes in serpentine. In the United Kingdom it is met with in Devonshire, Cornwall, Cumberland, and Aberdeenshire; in Ireland in the granite of co. Antrim, and in limestone at Killiney Hill. The chief foreign localities are Saxony, Bohemia, St. Gotthard, the Tyrol, Norway, Spain, Portugal, France, Bucharia in Asia, N. America, &c. It frequently contains fluoride of calcium. [PHOSPHORITE.]

Apatoid. A mineral found in very minute quantity in certain meteorites, in the form of small yellow transparent grains. The name Apatoid has reference to its external resemblance to Apatite; but it does not contain phosphoric acid.

Apaturia (Gr. ἀπατούρια). An Athenian festival, celebrated in the month Pyanepsion, by the Ionian cities, except Colophon and Ephesus. The name is derived from ἀ = ἅμα and πατριά, and so expressed the meeting of a people according to their Phratriæ.

Apaumé (Fr. paume, *the palm of the hand*). In Heraldry, a hand opened so that the whole palm is seen, with the thumb and fingers extended, as shown on the arms of baronets.

Ape (Anglo-Sax. apa). In the Zoological sense, is restricted to those higher organised species of the Linnæan *Simiæ* which are destitute of a tail. They are included in the modern subgenera *Troglodytes*, *Pithecus*, and *Hylobates*, or the chimpanzees, orangs, and gibbons.

Apelleans, or **Apellites.** In Ecclesiastical History, heretics of the second century, said to have entertained the doctrine that the body of Christ perished at his ascension.

Apellous (Gr. ἀ, priv., and Lat. pellis, *skin*). Destitute of skin.

Apennines. This principal spur of the higher Alps runs through and forms the backbone of Italy, having a total length of about 800 miles, and rising in the southern part to an elevation of more than nine thousand feet. Two of the great volcanic mountains of Europe, Vesuvius and Etna, belong to this chain, and recent volcanic action is traceable in many parts of the district around. The chain of the Dalmatian coast and Albania, on the other side of the Adriatic, extends into Greece, always parallel to the Apennines, and the two thus form a part of one great link connecting the Alps by a series of broken links with the Taurus chain, and so with the Asiatic mountain systems. The direction of the Apennines is on the whole south-east. The chain is narrow and continuous for the most part, but has some fine valleys and gorges, especially in the south

Apetalous (Gr. ἀ, priv., πέταλον, *a petal*). When a flower has a calyx only, and no corolla; sometimes extended to cases in which there is neither calyx nor corolla; thus, the apetalous plants of Jussieu are either destitute of a corolla only, or of all floral envelopes.

Apex (Lat.). The summit or highest point of anything. Thus, the apex of a cone, of a pyramid, &c.

Aphanipterous, Aphaniptera (Gr. ἀφανής, *unseen*, and πτερόν, *wing*). The name of an order of Apterous Haustellate insects, having rudimental elytra or wings in the perfect state, and undergoing a metamorphosis, resembling that of the *Tipulidæ*, or crane-flies. The common flea (*Pulex irritans*, Lin.) may be regarded as the type of this order. The female flea (*Pulex irritans*, Lin.) deposits a dozen eggs, of a white colour and rather viscous texture, from which proceed little apodal maggots, which are very active in their motions, winding themselves in a serpentine manner through the substance in which they may be deposited: the head of the larva is protected by a firm skin, and bears two small antennæ, but no eyes; the body consists of thirteen segments, bearing little tufts of hair, and the last is armed with a pair of hooklets: the mouth presents some small movable instruments with which the maggot hauls itself along. After having passed twelve days under this form, the larva spins itself a little silken cocoon, in which it passes into the pupa state, and in about twelve days more emerges a perfect flea; this metamorphosis distinguishes the flea and chigoe from other blood-sucking parasitic Apterous insects; and they are further distinguished by the number of segments into which their body is divided, and their pentamerous, or five-jointed, tarsi.

Aphelion (Gr. ἀπό, *from*, and ἥλιος, *the sun*). In Astronomy, is that point of a planet's orbit which is at the greatest distance from

the sun. It is opposed to perihelion, which signifies the point of the orbit nearest the sun. The aphelion and perihelion of an orbit are consequently the two extremities of its greater axis. In consequence of the mutual attractions of the planets, the positions and figures of their orbits are constantly undergoing a slow variation. The aphelia gradually shift their places on the planes of the orbits; and it is remarkable that these motions are direct, or eastward, in the case of all the planets excepting Venus, the aphelion of whose orbit, when referred to the fixed stars, moves westward at the rate of about 4 seconds annually. Of the old planets, Saturn is that whose aphelion undergoes the greatest annual variation; it amounts to about 18 seconds of a degree. [PERIHELION; PLANET.]

Apheresis or **Aphæresis** (Gr. ἀφαίρεσις, from ἀφαίρεω, *I take away*). In Grammar, a figure by which a letter or a syllable is cut off from the beginning of a word; as in the common abbreviation, ''t is,' for 'it is.'

Aphides. A family of emipterous insects, commonly called 'plant-lice,' inhabiting trees and plants, and living on their juices; remarkable for the anal saccharine secretion referred to in ANAL GLANDS, but more especially for a peculiarity of their generative economy, particularly described by Bonnet, and which consists in the first fecundation of the female influencing not merely the ova immediately developed thereafter, but those of the females resulting from that developement, even to the ninth generation, which are successively impregnated and productive without any intercourse with the male insects. Certain Coleopterous insects, which prey upon and keep in check the Aphides, are termed Aphidiphagi and Aphidivora (φάγω, *I eat*, voro, *I devour*).

Aphlogistic (Gr. ἀφλόγιστος). Without flame or fire.

Aphlogistic Lamp. A lamp with a glowing wick, the combustion in which goes on without flame.

Aphony (Gr. ἀφωνία, from ἀ, priv., and φωνή, *voice*). Loss of voice.

Aphorism (Gr. ἀφορισμός, from ἀφορίζειν, *to define*, or *limit*). A term chiefly used in Law and Medicine, but occasionally also in Moral Philosophy, &c., to denote a comprehensive maxim or principle expressed in a few words.

Aphrite (Gr. αφρός, *froth*). A nearly pure carbonate of lime, sometimes occurring in a very soft, loose and friable state, in beds and veins in the older rocks.

Aphrizite (Gr. ἀφρίζω, *to froth*). A subvariety of Tourmaline occurring in small, brilliant, black crystals in decomposed Felspar, at St. Just in Cornwall, and in the Harz. It froths under the blowpipe.

Aphrodisiac (Gr. 'Αφροδίτη, *Venus*). That which incites to venery.

Aphrodite (Gr.). In Greek Mythology, a name given to the Goddess of Love, who was identified with the Latin Venus. According to the Hesiodic Theogony (197), she sprang from the sea-foam, ἀφρός, after the mutilation of Ouranos by Kronos, and so received her name. In the *Iliad* and *Odyssey* she is the daughter of Zeus and Dione, the wife of Hephæstus, and the paramour of Ares. In the so-called Homeric hymns she is the mother of Æneas by Anchises.

APHRODITE. A soft and earthy mineral of a white or yellowish colour, and with a waxy lustre, found at Langbanshytta in Sweden. It is a hydrated silicate of magnesia, and resembles Meerschaum.

APHRODITE. This classical name was applied by Linnæus to a beautiful genus of Anellidans adorned with resplendent silky hairs and bristles, of which the seamouse (*Aphrodita aculeata*, Lin.) of our coasts is an example.

Aphroditidæ. The name of the family of Anellidans, of which the seamouse, or *Aphrodita aculeata*, is the type.

Aphrosiderite (Gr. ἀφρός, *froth*, and σίδηρος, *iron*). A ferruginous Ripidolite occurring in fine scaly grains in Nassau and Weilburg.

Aphthæ (Gr. ἀφθαί): In Medicine, the thrush; small round superficial ulcers, seated principally in the extremity of the excretory vessels, salivary glands, &c.

Aphthonite (Gr. ἄφθονος, *abundant*). A mineral resembling an argentiferous Grey Copper Ore. It occurs massive, of a steel-grey colour, at Wärmkog, in Wermland.

Aphyllantheæ. A small division of the Juncaceous order of Endogens, comprehending the genus *Aphyllanthes* from the south of Europe, with *Calectasia* and *Dasypogon* from New Holland.

Aphyllous (Gr. ἄφυλλος). Leafless. The term is, however, sometimes applied to plants in which the leaves are present, but so small as not to look so much like leaves as mere scales. Plants are also called leafless in which, although scales of a considerable size are present, there are no true green leaves: of this description are *Monotropa*, *Orobanche*, *Pyrola aphylla*, &c.

Apiaceæ (Lat. apium, *parsley*). One of the names of the natural order *Umbelliferæ*, constructed with more resemblance to the plan upon which the names of other natural orders are formed in Botany than that of *Umbelliferæ*.

Apiculate (Lat. apex, *a sharp point*). When a leaf or any other part is suddenly terminated by a distinct point.

Apidæ (Lat. apis, *a bee*). One of the varieties resulting from the modern division of the Linnæan genus *Apis*, including those species which are distinguished by the length of the terminal parts of the inferior organs of the mouth, which constitute a proboscis.

Apiine. A gelatinous substance (distinguished by affording a blood-red colour with solution of sulphate of iron), obtained from parsley (*Apium petroselinum*).

Apiocrinites (Gr. ἄπιον, *a pear*, κρίνον, *a*

lily). Pear Encrinite. [ENCRINITE.] The name of a sub-genus of fossil Encrinites, in which the body is formed of separate pieces articulated with the stem, and supporting the rays by similar articulations, in consequence of which the stem is rounded and dilated into a pyriform figure at its upper part.

Apion. A genus of minute Coleopterous insects of the weevil family (*Curculionidæ*); very numerous in species, distinguishable by their elegant pear-shaped form, protruded snout, and straight antennæ.

Apis. In Egyptian Mythology, a bull supposed to be the representative of the god Apis. This fact was held to be ascertained by the occurrence of certain signs in the body of the animal, which are specified by Herodotus, iii. 28. The bull was then consecrated, and received the highest worship. It was not suffered to live more than twenty-five years; and its death was followed by a solemn burial and a general mourning, until a new calf, with the requisite signs, was discovered. By the Greeks this god was called Epaphus, and was said to be the son of Io. The slaughter of Apis by Cambyses was assigned as the cause of his madness. (Herod. iii. 27.)

APIS (Lat. *a bee*). The Linnæan genus, now subdivided into different families, is thus characterised: mouth horny; jaw and lip membranaceous at the tip; tongue inflected; feelers four, unequal, filiform; antennæ short, filiform, those of the female subclavate; wings flat; sting of the females and neuters pungent, and concealed in the abdomen.

The insects of this extensive genus live some of them in large societies, and some are solitary; their food is the nectar of flowers, honey, and ripe fruit; the larva is soft and without feet; the pupa resembles the perfect insect.

The characters of the Linnæan genus are applicable to a variety of forms, now the types of numerous subgenera, included by Latreille in a family of Aculeate Hymenopterous insects, under the term *Anthophila*, or *Mellifera*. The habits of each of the subgenera of this family are replete with interest, arising from their social economy, and the separation of the individuals into three sexual modifications, viz., the prolific females, or queens; the unprolific females, or workers; and the males, or drones. The policy of the hive-bee (*Apis mellifica*, Lin.) has been studied with so much diligence and detail, that we penetrate this mystery of nature with astonishment, and often feel inclined to regard what Huber relates as fabulous. Nevertheless, the highly interesting observations of this writer, and those especially on which his reputation chiefly rests, have been confirmed by subsequent observers, both scientific entomologists as well as practical apiarians.

The hive-bee is distinguished from all other species of the modern genus Apis by having the femora of the posterior pair of legs furnished with a smooth and concave plate on the outer surface, and fringed with hair, forming a basket adapted for the conveyance of pollen: and in being destitute of spines at the extremity; by the basal joint of the tarsi, in the workers, being of an oblong form, with its inner surface clothed with hairs disposed in transverse rows; by the trophi being of an elongated form, and the maxillary palpi being almost obsolete and consisting of a single joint.

The different individuals of the social *Apis mellifica* more nearly resemble each other in their grade of developement—as regards their locomotive powers, organs of sense, and instinctive endowments—than the ants. No individual among them is without wings; and the industry of the workers, or imperfect females, is less astonishing, at least their tasks are less arduous, than fall to the lot of the Apterous labourers of the ant tribes.

As bees, like most other winged insects, are annuals, or go through the whole essential economy of their existence within the year, the history of a year's existence includes the whole, and we have only to choose the point in the circle at which to commence it.

As some individuals, however, always survive the winter, and begin to breed early in spring, forming a colony which quits the parent stock, we shall begin with this colony, and trace their operations through the year.

The first young swarm in this country is generally sent off in June. The migration seems to depend on want of space in the mother hive, not on an instinctive desire of change on the part of the brood; for if there be space for the operations of the increasing community, bees will not naturally swarm; and skilful apiarians sometimes take advantage of this circumstance, and, by making successive additions to the hive, retain the whole year's increase in the same building. The swarm consists in general of about six or seven thousand individuals, of which about one-thirtieth part are males, the rest females; and of these, one only, for the most part, is prolific, and she is called the queen. Her body is longer than that of either the drone or worker; her colours are brighter and purer, and generally of a darker shade: the transverse bands across the abdomen are of a deeper and brighter yellow, and are sometimes orange; the head is smaller than that of the unprolific female, and the tongue is shorter and more slender; her mandibles are notched, and her sting is curved; but the most obvious distinctive character is the proportional length of the abdominal segment of the body which lodges the generative apparatus, and which is of an elongate conical form, tapering rather sharply to the anus. The male bee is readily distinguished by the short and thick form of his body, which is obtuse at each extremity. He has no sting. The workers, like the queen, are armed with a sting, but it is straight, and proportionally larger and stronger. The workers are essentially females in their internal structure, but their growth is arrested before

arriving at the period when the full developement of the sexual system takes place, and they consequently are smaller than either the queen or the drones; and their colours are less bright. According to Huber, there are two varieties of labourers, one of a larger size, which he calls 'abeilles cirières,' or makers of wax; the other, or smaller variety, he terms 'abeilles nourrices,' or nurse-bees, whose crop or first stomach is not capable of the distension requisite for collecting honey, but whose office is to build the combs and cells after the foundation has been laid by the cirières, and to feed the larvæ.

It is also stated there are two kinds of drones; one not larger than the workers, the other as above described. And Huber has described another variety of the inmates of the hive, which he terms 'black bees,' and which are supposed to be the superannuated workers.

The swarm, thus composed, commonly leaves the hive in the heat of the day, and often immediately after a shower. It is supposed that the queen takes the lead, and she ever afterwards exercises an inscrutable influence over all their operations. Perhaps a stronger proof that instincts do not necessarily depend on physical conformation is not afforded by any phenomenon in natural history, than by the effects which the loss or death of the queen produces on the labourers. This event does not deprive them of any organ, or paralyse any limb; yet, the moment they are conscious of her loss, all their labours are interrupted and forsaken, and, unless another queen be provided, they join another hive, or perish from inanition.

The flight of the swarm is directed to some neighbouring fixed place, and wherever the stand is made they all forthwith repair to it. In the wild state, the cavity of an old tree is commonly chosen; and this, with a seeming prudence and foresight which cannot be sufficiently admired. The first care of the bees is to cleanse it from dust and rubbish, and to gnaw off with their mandibles any asperities or projections which might interfere with the future construction of the comb. In the state of domestication in which the hive-bee is usually preserved in this country, the practice of the above instinctive actions is rendered unnecessary, by the reception of the swarm into neat artificial hives. Yet this modification of their habits, and many other interferences to which they are subject, have had no effect in inducing any varieties in the organisation of the bee, nor any change in those instinctive actions which the care of man has not rendered indispensable. The consideration of this curious exception to the ordinary consequences of domestication, and of the conditions on which the circumscribed limits of variation in the bee depend, would lead us far beyond the extent allotted to the present subject; but it is an inquiry full of interest in relation to the recondite laws which govern the variation of animals from their specific standard.

In the wild state, the young colony at first return occasionally to the parent establishment for supplies of provision; and the domesticated bees always fill their crops with honey before they leave the hive. The wax is a peculiar secretion from the working bee; and having the materials, therefore, within themselves, they immediately begin to form the comb.

Before describing the many-chambered nursery and storehouse which our bees are about to prepare, a few words are necessary regarding the material of which it is constructed.

The formation of the wax is a very singular and complex operation. Huber says, 'The wax-makers, having taken a due portion of honey or sugar, from either of which wax can be elaborated, suspend themselves to each other, the claws of the fore legs of the lowermost being attached to those of the hind pair of the uppermost, and form themselves into a cluster, the exterior layer of which looks like a kind of curtain. This cluster consists of a series of festoons or garlands, which cross each other in all directions, and in which most of the bees turn their back upon the observer: the curtain has no other motion than what it receives from the interior layers, the fluctuations of which are communicated to it. All this time the nurse-bees preserve their wonted activity, and pursue their usual employments. The wax-makers remain immovable for about twenty-four hours, during which period the formation of wax takes place, and thin laminæ of this material may be generally perceived under their abdomen. One of these bees is now seen to detach itself from one of the central garlands of the cluster, to make a way amongst its companions to the middle of the vault or top of the hive, and by turning itself round to form a kind of void, in which it can move itself freely. It then suspends itself to the centre of the space which it has cleared, the diameter of which is about an inch. It next seizes one of the laminæ of wax with a pincer formed by the posterior metatarsus and tibia, and drawing it from beneath the abdominal segment, one of the anterior legs takes it with its claws and carries it to the mouth.'

The wax has, perhaps, the nearest analogy to the sebaceous secretion of the integument than to any other animal secretion: it is formed beneath the scales on the under side of the abdomen, and, when accumulated there, seems to irritate the part, for the bee may then be observed wagging her abdomen, and running round, or to and fro, as if endeavouring to shake out the little scales; and she is generally followed by one or two other bees which have been attracted by her movements, and are ready to seize upon the plates of wax as they fall. How the bees mould the scales into the walls of the cells is not yet exactly understood. Some have supposed that they bite pieces off and join them together; but the smooth and uniform surface of the cell shows that some other operation must take place: besides, the wall of the cell is sometimes thicker than a

scale of wax. We must, therefore, suppose that the bees have the power of applying some dissolving or softening menstruum to the wax scales, by which they are enabled to knead and blend them into a ductile paste. And when we remember that the secretion of the salivary tubes of insects is generally alkaline, and that wax may be softened by alkali, it has been naturally supposed that it is by this means that the wax-scales are brought into a workable state. Reaumur, indeed, observed a frothy substance exuding from the mouth of a bee while working at a cell, which was applied to the proper place by the nimble tongue, and then kneaded in by the mandibles; and Huber has described the process very circumstantially: he says that the bee holds the lamina of wax with its claws vertically—the tongue rolled up serving for a support—and by elevating or depressing it at will causes the whole of its circumference to be exposed to the action of the mandibles, so that the margin is soon gnawed into pieces, which drop, as they are detached, into the double cavity, bordered with hairs, of the mandibles. These fragments, pressed by others newly separated, fall on one side of the mouth, and issue from it in the form of a very narrow riband. They are then presented to the tongue, which impregnates them with a frothy liquor. During this operation the tongue assumes all sorts of forms: sometimes it is flattened like a spatula; then like a trowel, which applies itself to the riband of wax; at other times it resembles a pencil, terminating in a point. After having moistened the whole of the riband, the tongue pushes it so as to make it re-enter the mandibles, but in an opposite direction, where it is worked up anew. The liquor mixed with the wax communicates to it a whiteness and opacity which it had not before, and doubtless gives it that ductility and tenacity which it possesses in its perfect state.

Bees commonly begin at the top or roof of their chamber, and build downwards, at first working irregularly, and as it were pasting over the surface, and then building horizontal cells of a more perfect form. These at length become so numerous, that they extend downwards in the form of a vertical wall; other congeries of cells are formed in succession, until the whole comb assumes the form of a series of perpendicular plates or partitions. Each plate consists of a double set of cells, the bottoms of which are applied to each other and form the partition between each set. The plates are not always regular, and the irregularities which may be observed are not always necessary adaptations to a peculiar form of the cavity in which they are built. The cells are not all of the same size, but a sufficient number of a given depth are reserved for receiving the eggs, and which are necessarily adapted to the size of the future maggot: the smaller or shallower cells are those in which the honey is stored. The breeding and store cells are placed horizontally, but the mouth of the cell is sometimes a little raised—the better to retain the honey. The interspace between the vertical combs is generally about half an inch: these streets, as they may be termed, in this city of industry, being just wide enough to allow two bees busied upon the opposite cells to pass without incommoding each other. In addition to these interspaces, the combs are perforated in various places, so as to allow a passage for the bees from one street to another, thus saving them much time.

The shape of each cell is not, as might have been expected, cylindrical, or that which seems best adapted to the form of the maggot, or even of the constructor bee; but it is hexagonal—the only form which allows the cell to be of the largest size in proportion to the quantity of matter employed, and at the same time to be so disposed as to occupy in the hive the least possible space. The form of the base of each cell, which is in apposition with the one on the opposite side, is also such as to gain greater strength, and more capacity, with less expenditure of wax; the latter consideration being one of great importance to bees, which do not secrete a very large quantity of this material: and the most profound mathematicians and most skilful geometers have found the solution of the problem, relating to the attainment of the preceding objects, as derived from the infinitesimal calculus, to have a surprising agreement with the actual measure of the different angles formed by the walls of the cell.

There may generally be observed one or more cells, wider and shallower than the rest, placed either on the edge of a comb, or partition; or placed against the mouths of the cells, and projecting beyond the general surface of the comb. These are called the royal cells; but as they are not adapted to the form of the queen, nor ever lined with the silken covering of the chrysalis, the supposition that the queen is bred in them seems improbable.

Having now generally described the comb, we return to the consideration of those instinctive operations by which its several compartments are furnished with their destined contents.

The comb seems at first to be formed entirely for propagation, and, indeed, to be essentially related to that function; for if the workers lose their queen, they make no combs; and the reception of honey is, therefore, its secondary use. Wasps and hornets make combs, although they collect no honey.

As soon as the young colony has prepared a few combs the female begins to exclude her eggs. The first that she lays produce the imperfect females, or workers; the subsequent ones produce the males, and, perhaps, the fertile females, or queens. The eggs are deposited at the bottom of the cells, often before these are half completed; they adhere generally by one end to the cell. In about five days the little maggot is hatched, and is seen lying at the bottom of the cell, coiled up in a transparent fluid.

Now begins the additional employment of the

labourers, that of feeding and nursing the young maggots; for this purpose new materials must be collected abroad, and brought into the hive.

At first the bees of a young colony fly out singly, and afterwards collectively. They direct their flight generally in a straight line, or the nearest way to the destined object, and often travel to great distances from the hive. In summer time they may be seen almost everywhere where flowers bloom. In April and May they are abroad the whole day; but in the hot months they venture out less frequently, generally in the morning and evening, at which times it is more easy for them to form the pellets of the pollen, the grains of which adhere together less strongly during the heat of noonday.

Bees do not like wet weather; yet it is perhaps less the presence of rain, than the changes in the degree of light, which deters them from venturing abroad at this time: for they possess large and complex organs of sight, and when clouds collect quickly over the clear sky, they are seen to hurry back in great numbers to the hive; while if the sky be uniformly overcast, it is not merely a shower of rain that will drive them back: many of the actions of the bee prove, on the contrary, how essential moisture is for them. The bee does not take honey indiscriminately from every flower; in the meadows they may be seen generally upon the Orchideæ, Polygoniæ, Caryophylaceæ, but seldom, if ever, upon the Ranunculaceæ, perhaps on account of some poisonous quality. The oleander (*Nerium oleander*, L.), which yields poisonous honey fatal to thousands of flies, is carefully avoided by bees; and the crown imperial (*Fritillaria imperialis*, L.), the white nectaries of which are so conspicuous, tempts in vain the passing bee. They are, however, extraordinarily active in spring at the blossoming of the Amentaceæ, Rosaceæ (especially the dog-rose), and the balsamic lilies, Primulaceæ, &c.; and are, above all, allured by the innumerable flowers of the lime (especially *Tilia parvifolia*), and their hum may be heard among the branches at some distance. The finest flavoured and most delicate honey is collected from aromatic plants; and it is therefore always advisable to have large beds of borage, mignionette, lemon thyme, and sage in the neighbourhood of beehives. Those flowers which yield a nectar innocuous to the bees themselves, but possessing poisonous qualities when taken by man, are sometimes frequented by bees, and the honey derived from them acts like a poison. The description by Xenophon of the intoxicating or maddening honey, which so violently affected a number of the ten thousand Greek soldiers in his celebrated retreat, has been confirmed by the observations of Tournefort; and Dr. Barton, in his account of the poisonous honey collected from the *Kalmia latifolia* by the bees in Pennsylvania, justly observes, that there is more of poetry than philosophy in the following lines of Pope:—

> In the nice bee what sense so subtly true,
> From poisonous herbs extracts the healing dew.

The honey which is swallowed by the bee passes into the crop, where it is accumulated as in a reservoir, and upon the return of the bee to the hive is regurgitated into a honey cell. If any honey had been previously accumulated there, the bee breaks through the firm cream-like crust which always forms upon the exposed surface of the honey; and it is this crust which maintains the honey in the horizontal cells.

The collection of the farina, or pollen, of flowers is a great object of the industry of bees. In large flowers, as the tulip, the bee dives in; and if the pollen receptacle, or anther, be not burst, she bites it open, and comes out singularly disguised, being covered over entirely with the fertilising dust, which adheres readily to the fringed hairs of her body and legs.

Aristotle, who was well acquainted with much that is interesting in the economy of the bee, was the first to observe that a bee, during each single excursion from the hive, limits her visits to one species of flower. Modern naturalists have confirmed the general accuracy of this statement, and have noticed that the pollen with which a bee comes home laden is always of the same colour. The necessity of this instinct arises out of the operation which the pollen first undergoes when collected by the bee. She rakes it out with incredible quickness by means of the first pair of legs; then passes it to the middle pair, which transfer it to the hind legs, by which it is wrought up into little pellets. Now, if the pollen were taken indiscriminately from different flowers, it is probable that the grains, being heterogeneous, would not cohere so effectually. Certain it is, that bees enter the hive, some with yellow pellets, others with orange, pink, white, or even green-coloured ones; but they are never observed to be party-coloured. Through this instinct, another important end is gained, in relation to the impregnation of flowers; the production of hybrid plants by the application of the pollen of one species to the stigma of another is avoided—while those flowers are more effectually fertilised which require the aid of insects for that purpose.

When a pollen-laden bee arrives at the hive, she generally walks or stands upon the comb beating her wings, and three or four of her fellow-citizens assist in lightening her of her load; or the laden bee puts her two hind legs into a cell, and with the intermediate pair, or the extremity of the abdomen, brushes off the pellets. These are then kneaded into a paste at the bottom of the cell; and several cells are thus filled with the packed and softened pollen, which is called bee-bread.

Besides the honey and farina, bees also collect a peculiar substance, like gum-resin, which was called 'propolis' by Pliny; and this they obtain principally from the balsamic buds of the horse-chestnut, birch, and poplar, especially the *Populus balsamifera*, L. The

propolis is soft, red, will pull out in a thread, and is aromatic. It is employed in the hive, not only in finishing the combs, but also in stopping up every chink or orifice by which cold, wet, or any enemy can enter. Like the pellets of pollen, it is carried on the posterior tibiæ, but the masses are lenticular. Having thus traced the operations of the working bees relating to the collection of the substances required in the economy of the hive, we shall now return to the larvæ, which are the immediate objects of all this industry.

The bees may be readily detected feeding the young maggot, which opens its lateral jaws to receive the bee-bread, and swallows it. The well-fed maggot soon grows too large for its tough outer skin, and accordingly casts it; when its bulk has increased so that it fills its cell, it then requires no more food, and is ready to be enclosed for the chrysalis state. The last care of the foster-parents is to cover over the mouth of the cell with a substance of a light brown colour, apparently a mixture of wax and farina. This takes place generally four days after the larva was excluded from the egg. The enclosed larva now begins to line the cell, and covering of the aperture before mentioned, with a silk, which it spins from glandular tubes, similar to those of the silkworm. When the first three segments of the trunk, to which the locomotive organs of the perfect insect are attached, begin to be enlarged, the last larva-skin splits along the back, and is pushed off from the head backwards, and deposited at the bottom of the cell, and it then becomes a chrysalis. Now the wonderful changes take place, partly by a formation of new organs, partly by a developement of pre-existing ones, which end at last in the completion of the perfect bee.

Mr. Hunter ascertained the duration of the pupa state of the bee to be, in one instance, thirteen days and twelve hours exactly; making the period of immature life, from the first deposition of the egg, to be twenty-two days and a half—a remarkably brief time for the completion of the metamorphoses, as compared with that in which the corresponding changes are effected in other metabolian insects. When the bee first comes forth it is of a greyish colour, but soon assumes the ordinary brown tints.

When the season of oviposition and the rearing of the larvæ is over, then the business of collecting honey seriously begins; and when the last chrysalis of the season has disclosed its imago, the deserted cell is immediately filled with honey, and covered over with wax, to serve as a store for winter.

In the month of August it is supposed that the prolific female, which is to produce the swarms of the following year, is impregnated. This act takes place in the air. The queen, being preceded by the drones, traverses the exterior of the hive, and suddenly rises aloft in the air, wheeling upwards in large circles, until she is out of sight. The male, unable to extricate the intromitted parts, generally perishes. The rest of this unhappy sex share a similar fate, and meet a violent death from the jaws of the unprolific females. It would seem as if the drones were conscious of their danger at this season, for they do not loiter as usual at the mouth of the hive, but hurry in or out. However, they are attacked, by one, two, or three workers at a time, who do not sting them, as Huber asserts, but pinch them and pull them about, as if to wear them out. From this instinctive and indiscriminate slaughter of the males, we may infer that the impregnation of the queen has taken place before the setting in of the winter season; and that the ova, the developement of which is retarded during the indolent state in which bees pass through the cold months, are in a condition to be developed and produce the larvæ at the approach of spring. Yet, although on the setting in of the cold weather the bees remain very quiet, they are not torpid, as is the case with most other insects. They cluster as close together as the comb will permit, and have the faculty of generating a degree of heat superior to that of the external atmosphere.

Mr. Hunter found, during an evening in July, when the temperature of the atmosphere was 54°, that of the interior of a hive full of bees was 82°; and in December, the external atmosphere being 35°, the bees preserved a temperature of 73°; and, what is, at this season, extremely rare in the lower animals, they maintain their digestive powers, and subsist on the produce of the summer and autumn. Accordingly, they are ready to take advantage of any fine and mild day, and may be seen then flying abroad and appearing to enjoy it. They void their excrements at this time, for they are insects of singular cleanliness and propriety; and when purposely confined in the hive, with abundance of food, they have been known to fall a sacrifice to this instinctive repugnance to defile the hive.

The continuance of the digestive actions during the winter influences the condition of the oviducts in the queen, and the impregnated ova begin early to expand, and are ready for exclusion in the month of March. This makes the bee the earliest breeder amongst the insects of this country. The labourers now resume their accustomed duties, and, as the season is too early for collecting the provision of the maggot abroad, the store of bee-bread, laid up in the preceding year, comes into use for the sustenance of the larvæ, which are about to form the first swarm. As soon, however, as the flowers begin to blow, the bees fly forth to gather fresh pollen, propolis, and honey, and the labours of the year recommence.

It appears to be the presence of the larvæ destined to become perfect females which stimulates the old queen to leave the hive. After repeated attempts to penetrate their cells, and destroy her royal progeny, she becomes infuriated, communicates her agitation to a portion of her subjects, which, together

with her, rush out of the hive, and seek a new domicile. It is stated that in every instance the old queen leads the first swarm; the labourers that remain pay particular attention to the royal larvæ that remain; and these, as they are successively excluded, lead away fresh swarms, if the hive be not sufficiently enlarged. Each swarm contains, not only the recently hatched young bees, but also a portion of the old inhabitants. Some assert that the queen which leads each swarm is impregnated soon after the new colony is settled; and, as this may take place early in the summer, she begins to oviposit the same year. The number of ova which are fertilised by a single coupling is prodigious: Huber calculates that the queen lays 12,000 eggs in two months; while, according to Reaumur, she oviposits at the rate of 200 a day. The duration of life of the different individuals of the hive varies: that of the male bee is not more than two or three months; there is more doubt respecting the longevity of the workers, but it is probable that it does not extend much beyond a year. The term of the queen's existence has been stated to be prolonged for five years; but this is rendered improbable by the fact that all insects of the same species have nearly the same duration of existence allotted to them.

The true honey-bee (*Apis mellifica*, L.) was originally limited in its geographical range to the Old World, whence it has been transported to America, and other countries where European colonies have been established, and where it is now acclimated. The distinguished entomologist Latreille, on whose authority we state this fact (*Règne Animal*, tom. v. p. 365.), is even of opinion that the honey-bee of the south and east of Europe, as well as that of Egypt, differs specifically from the *Apis mellifica* of Western Europe.

Apistes (Gr. ἄπιστος, *treacherous*). A genus of Acanthopterygious fishes, notable for a strong suborbital spine, with which they are apt to inflict severe wounds when incautiously handled.

Apjohnite. A kind of manganesian alum found in acicular crystals with a silky lustre, like Asbestos, near Lagoa Bay in S. Africa.

The name Apjohnite has also been given to a metallic ore of a brownish-leaden colour, found in Ireland, mixed with Iron Pyrites. It is composed of bisulphide of iron, sulphide of lead, and sulphide of zinc.

Aplanatic lens (Gr. ἀ, *without*, and πλάνη, *deviation*). In Optics, a lens such that rays parallel to its axis, or rays diverging from a point in its axis, after passing through it and suffering refraction at its surfaces, converge to a single point, or the true focus. In order therefore to be aplanatic, the lens must not only have the true geometrical figure necessary to destroy aberration, but must also be constructed of different media, so as to correct the effects of the unequal refrangibility of the different rays, that is to say, it must be achromatic. Neither of these conditions can be accurately fulfilled in practice; the object aimed at is therefore to give the lens such a form that, with a given index of refraction, the aberration shall be the least possible. [ABERRATION; ACHROMATISM.]

Aplome (Gr. ἁπλόος, *simple*). A variety of Garnet. The name has reference to the derivation of the rhombic dodecahedron (in which form it commonly occurs), from the cube, by one of the simplest laws of decrement.

Aplotaxis (Gr. ἁπλόος, *single*, and τάξις, *a series*). To this genus of *Compositæ*, which is found in the Alpine and temperate parts of the Himalaya, belongs the costus of the ancients, *A. Lappa*, which has also been described under the name of *Aucklandia Costus*. This is found on the mountain slopes of the Kashmir valley, and is a gregarious herb, with thick perennial aromatic roots, a tall annual stem, lyrate-pinnatifid leaves, and purple flowerheads. Large quantities of the roots, said to amount to 200,000 lbs. weight, are annually collected for exportation. The root is used by the Chinese as an aphrodisiac, and for burning as incense in their temples.

Aplysia (Gr. ἀπλυσία, *uncleanness*). A genus of Tectibranchiate Gasteropods, well known to the ancients under the name of *Lepus marinus*, or sea hare, from a resemblance which the long tentacles give it to the head of the hare. By Aristotle, the name was applied to certain zoophytes, but was arbitrarily transferred by Linnæus to the molluscous animals now known under this denomination.

Apocalypse (Gr. ἀποκάλυψις). The book of Revelations, the last in the canon of the New Testament. Many conflicting opinions have been entertained as to the authenticity of this book. It was rejected by Luther, but the opinion of the great majority of orthodox critics and divines in modern times has been decidedly in favour of its genuineness. There have, also, been great varieties of opinion as to the person by whom, and the period when, the book was written: but the prevalent opinion is, that it is the work of St. John the Evangelist. See, for a searching examination of this question, Alford's *Greek Testament*, and the authorities there cited. Compare also *National Review*, April 1864, art. 'Apocalypse of St. John.' The phrase 'apocalyptic writings' is frequently used to designate those other portions of the Scriptures which contain prophetic descriptions, under the form of visions, of the future state of the church: such as the book of Daniel; and, among the Apocrypha, the fourth book of Esdras.

Apocarpous (Gr. ἀπό, *from*, and καρπός, *fruit*). When the carpels of a flower either do not adhere to each other at all, as in the straw berry, or only by the ovaries, as in *Nigella*. When a carpel is altogether single in a flower, it is considered, for systematic purposes, apocarpous, the supposition being that if another carpel were present it would not adhere to the first.

Apocrenic acid (Gr. κρήνη, *a fountain*).

An extractive or brown matter found in some spring waters, and in ordinary vegetable mould. It contains ammonia.

Apocrisiarius (Gr. ἀποκρίνομαι, *I answer*). In Ecclesiastical History, one who resided at the Emperor's court in the name of a foreign church or bishop. The office was established by law in the time of Justinian; and the name was at length confined to the papal nuncio who resided at Constantinople.

Apocrypha (Gr. ἀπόκρυφα). Properly, things concealed or put out of sight; applied to books, in behalf of which a claim to inspiration has been put forth, but which are supposed to be spurious, and are therefore rejected from the canon of Scripture. One great distinction between the Roman and the Reformed churches is, that the latter reject certain books, admitted by the former on the same footing as those books about which there is no dispute, from the canon of the Old Testament; viz. the third and fourth of Esdras, the book of Tobias, that of Judith, the rest of the book of Esther, that of Wisdom, of Jesus the son of Sirach, Baruch the prophet, the Song of the Three Children, the story of Susanna, of Bel and the Dragon, the Prayer of Manasses, and the first and second Maccabees; reading them, as the sixth Article of the English church declares, for example of life and instruction of manners, but not applying them to establish any doctrine. The English church receives no books into the canon of the Old Testament which were not so received by the Jews; and it appears that the writings thus excluded are not quoted by the authors of the New Testament, nor are admitted into any of the earlier catalogues set forth by the Christian fathers. There exist at the present day various writings purporting to be the Gospels or Epistles of Joseph, of James the Apostle, of St. Paul, an Epistle of Christ himself to king Abgarus, &c.; which are, for the most part, intrinsically absurd; and, having no external evidence or authority in their favour, have never obtained currency in the church. [Canon.]

Apocynaceæ. An extensive natural order of plants, named after *Apocynum*, one of the more common of its genera. A few species are found in cold climates, but by far the larger part are natives of warm or tropical latitudes, in the form of shrubs or trees, or twining plants, some of which are remarkable for their beauty, as various species of *Echites*; others for their poisonous properties, as *Cerbera*, which furnishes the Tanghin poison of Madagascar; while a third set produce bark, having useful bitter and febrifugal properties. The inspissated milk that flows from these plants constitutes their poison; the febrifugal bitter principle is an independent secretion, that becomes useful when it can be separated from the milk. Notwithstanding these dangerous properties, the fruits of some species are eatable, as that of *Carissa*, the cream fruit of Sierra Leone, and some others.

Apode or **Apoda** (Gr. ἀ, priv. and πούς, *foot*.) Footless. A term applied by Latreille to a section of Saurians or lizards, by Meyer to a family of serpents, and by Opfel to a family of Batrachians; by Linnæus to his first order of fishes which have no ventral fins; and by Cuvier a suborder of Malacopterygia, or soft-finned fishes, is thus designated, comprehending those which are devoid of the ventral fins, or the homologues of the posterior extremities. It is also indicative of those larvæ of insects which have only the soft tubercles or prolegs; and as the skins of the bird of paradise, imported as an article of commerce, were always deprived of the legs, it was for some time believed that the species was naturally without feet, and it was consequently termed *Paradisea apoda*.

Apodictic (Gr. ἀποδεικτικός, *demonstrative*). A philosophical term adopted by Kant from Aristotle, to distinguish judgments which are beyond contradiction from those which are merely empirical.

Apodogynous (Gr. ἀ, priv., πούς, *a foot*, and γύνη, *a female*). A name given by Richard to disks which do not adhere to the base of an ovary.

Apodosis (Gr. from ἀποδίδωμι, *to give back*). In Grammar and Rhetoric, the second part of a period. [Protasis.]

Apogee (Gr. ἀπό, *from*, and γῆ, *the earth*). Applied, in Astronomy, to the orbit of the moon and the apparent orbits of the sun or planets, to denote the points of those orbits most remote from the earth. It is opposed to perigee, which denotes the point nearest the earth. The apogee of the lunar orbit advances eastward among the stars, and completes a revolution in about nine years.

Apoglucic Acid. Oxidised glucic acid.

Apollinarians. In Ecclesiastical History, a sect who denied the humanity of Christ as far as regards the soul, believing its place to be supplied by the *Logos*, or Word of God. Apollinaris, their founder, was a bishop of Laodicea in the latter part of the fourth century: his doctrine was condemned by the council of Constantinople, A.D. 381.

Apollo, or **Phœbus.** In Greek Mythology, the god of Light and Day, represented with very various attributes, all of which may be traced to the early mythical speech on the action of the sun. The Homeric hymn to Apollo is made up of two poems, the earlier of which relates that his mother, Lêto, or Latona (whose name may be identified with the Greek *Lethe*, and the Latin *Letum*), took refuge in Delos, where Apollo was born, and where she promised that he should dwell for ever. The later hymn speaks of him as forsaking Delos, and wandering to Delphi, where he slays the dragon Python, which reappears in Northern Mythology as the serpent Fafnir. Many amours are attributed to Apollo, among the most noted being that with Daphnê (a name identified with the Sanskrit *Dahanâ* or Dawn), which represents her as flying from the god to her father Peneios, the later legend adding that

she was turned into a laurel tree. For a complete analysis of this subject, see Max Müller's *Comparative Mythology* in *Oxford Essays* for 1856.

Apollo Belvidere. A beautiful statue of Apollo, found, towards the end of the fifteenth century, among the ruins of the ancient Antium. It was purchased by Pope Julius II., who placed it in the Belvidere of the Vatican, whence it takes its name. It is, perhaps, the noblest work of art. The god is standing, about seven feet high, and almost naked. His quiver hangs over his right shoulder; his pallium over his left arm, which is extended; and in his hands are the remains of a bow, out of which he is supposed to have just discharged the arrow that killed the serpent Python. The whole figure has about it an indescribable air of grace, beauty, and majesty.

This *chef-d'œuvre* of Greek sculpture has been supposed by some, but on very slight grounds, to be referred to by Pliny (*Hist. Nat.* xxxvi. 4). The best critics are of opinion that the artist is wholly unknown. This noble statue was conveyed to Paris by Napoleon; but, on the downfall of the latter, it was again restored to the Vatican.

Apollonicon, a chamber organ of vast power, constructed by Messrs. Flight & Robson, of London, in 1817. It had 1,900 pipes, some of them of immense size, forty-five stops, and was provided with five key-boards and two barrels. The whole of the accessories were on a very complex scale.

Apollyon. A Greek name signifying *the destroyer*, and answering to the Hebrew *Abaddon*.

Apologue (Gr. ἀπόλογος). In Literature, a fable or fiction, of which the object is moral. According to some definitions of the Apologue, it is a fable of which the interlocutors or subjects are animals; but this seems an unfounded limitation. [Fable.]

Apology (Gr. ἀπολογία). In Literature, a defence, or answer to an accusation. The two pieces of Xenophon and Plato, each commonly termed Apologia Socratis, differ in character: the first being a defence supposed to be pronounced by the philosopher himself; the last, a narrative of his last hours and discourses. Treatises in defence of the Christian religion, in its early period, were denominated Apologies by their writers; as those of Justin Martyr, Tertullian, and others, both preserved and lost. The title has been retained by some writers in modern times: as by Robert Barclay, in his Apology of Quakerism, by Bishop Watson, in his Apologies for the Bible and for Christianity, and more recently by Dr. Newman in his *Apologia pro Vitâ suâ*.

Aponeurotic (ἀπό, *from*, and νεῦρον, *nerve*). A term used in Anatomy, applied to the flattened membranes, *laminæ* or *fasciæ*, in which the separate fibres of the voluntary muscles are arranged. The involuntary muscles, on the contrary, are densely interlaced at various angles, the layer formed by them usually circumscribing the wall of a cavity constricted by the muscular fibre.

Apopemptic (Gr. ἀποπέμπω, *I send away*). In Poetry, a poem addressed to one departing from his country on a journey. Horace, book i. ode 3, is commonly cited as a noted example. In modern poetry, a finer instance can hardly be found than Schiller's lines addressed to the Duke of Saxe-Weimar on his going to France: 'So bringet nun die letzte volle Schale,' &c.

Apophthegm (Gr. ἀπόφθεγμα, from φθέγγομαι, *I speak*). A short and sententious speech or saying. The apophthegms of the ancients are generally sentences expressing some truth of universal application in philosophy, the conduct of life, &c. &c. Such are Plutarch's 'Apophthegmata Laconica,' a collection of the brief and pointed sayings for which the Lacedæmonians were famous.

Apophyge (Gr. ἀποφυγή, *a flying off*). A term used by writers on Architecture to express the hollow connecting the top of the shaft of a column with the fillet immediately above it; and also the similar hollow connecting the bottom of the column with the fillet at the base.

Apophyllic Acid. A product of the oxidation of cotarnine.

Apophyllite (Gr. ἀποφυλλίζω, *to exfoliate*). A zeolitic mineral with a lamellar structure, the name of which has reference to the way in which it exfoliates before the blowpipe. It is a hydrated silicate of lime and potash, occurring in square prisms, the solid angles of which are sometimes replaced by triangular or rhombic planes. The colour is white or greyish, often with a tinge of green, yellow, blue, or red; transparent to opaque, brittle, lustre shining or pearly on planes of cleavage. It is found in drusic cavities of amygdaloidal rocks at Ratho near Edinburgh; near Raith in Fifeshire; Old Kilpatrick in Dumbartonshire; Talisker in Inverness-shire; Portrush; Ballintoy, county Antrim; also in Greenland, Iceland, Hindostan, the Tyrol, Harz, Bohemia, Saxony, Siberia, North America, &c.

Apophysis (Gr. ἀπόφυσις). A protuberance, process, or projection. In Anatomy, restricted to processes of the osseous system.

Apoplexy (Gr. ἀποπληξία, *stupor from a blow*). A sudden suspension or loss of the powers of sense or motion; the heart continues to act, and respiration is continued, though often with some difficulty.

Aporobranchians, Aporobranchiata (Gr. ἀπορέω, *I am in want*, and βράγχια, *gills*). A name applied by Latreille to an order of the class Arachnida, characterised by the absence of stigmata or respiratory pores on the surface of the body.

Aposepedin (Gr. ἀπό, *from*, and σηπεδών, *putrefaction*). A peculiar crystallized substance obtained from putrid cheese. [Leucine.]

Aposiopesis (Gr.). A figure in Rhetoric and Composition, by which a sentence is made to break off abruptly when unfinished either in sense or grammatical construction; so that the

part which was to follow appears to be retained in the mind of the speaker or writer. In writing, the Aposiopesis is now often denoted by an horizontal line or break—at the point where the sense is interrupted.

Apostasiaceæ. A very small natural order of plants found in the tropics of India, closely allied to *Orchidaceæ*, from which they differ in having a three-celled ovary and diandrous flowers, the sexes of which are partly free. *Apostasia* is the principal genus.

Apostill. In Literature, a marginal note to a book.

Apostle (Gr. ἀπόστολος). A person sent forth upon any business: hence applied, by way of eminence, to the twelve elect disciples of Christ, who were sent forth by him to convert and baptize all nations. In the first century, the apostles assumed the highest office in the church; and the term apostle during that period was equivalent to bishop in after times. According to Theodoret (v. Bingham, *Antiq.* II. ii. §1.), the titles of bishop and presbyter were originally applied promiscuously to the same, or second, order in the church.

Apostles' Creed. A confession of faith, supposed anciently to have been drawn up by the apostles themselves, and deriving the title 'Creed' from the word with which it begins in Latin (credo, *I believe*). With respect to its antiquity, it may be affirmed that most of its clauses are quoted by the apostolic father Ignatius; and that the whole, as it now stands in our liturgy, is to be found in the works of St. Ambrose, in the fourth century.

Apostolic Fathers. The writers of the Christian Church, who lived in the apostolic age, or were during any part of their lives contemporary with the apostles. They are five: Clement of Rome, Barnabas, Hermas, Ignatius, and Polycarp; of whom the last suffered martyrdom, A.D. 147. Of these the three first are supposed to be mentioned in the Epistles and Acts; the fourth, according to a prevalent tradition, was the child whom Christ took in his arms, whence he was called Theophorus; and the fifth, who suffered at a very advanced age, seems to be the angel or bishop of Smyrna whom St. John addresses in the Revelations.

Apostrophe (Gr. *a turning away*). In Rhetoric, a figure of speech by which the orator or writer suddenly breaks off from the previous method of his discourse, and addresses himself in the second person to some person or thing, absent or present. It is not necessarily an address to the absent or dead, although often so defined. An orator, who should suddenly direct his speech to one of the audience, would be employing an apostrophe. It is, like other figures of speech, an imitation of one of the most natural effects of strong emotion. In oratory, the Apostrophe of Demosthenes to the gods, at the end of the *Oratio de Coronâ*, and, in narrative writing, that of Tacitus to the shade of Agricola in his biography of that statesman, may be cited as splendid examples of the use of this figure.

Apothecary (Gr. ἀποθήκη, *a storehouse*). Apothecaries were originally the venders and preparers of drugs and compounds used in medicine. Their practice in England is regulated by the act 55 Geo. III. c. 194. See also 21 & 22 Vict. c. 90; 22 Vict. c. 21; 23 Vict. c. 7; 23 & 24 Vict. c. 66; and 25 & 26 Vict. c. 91. The Apothecaries' Company, or the Society of Apothecaries of the City of London, was incorporated by James I. in 1606. Their last charter bears date 6th of December, 1617. [COMPANIES.]

Apothecium. A flat disk, consisting of a nucleus surrounded by a border, in which the asci of lichens are inclosed. It is commonly called a shield.

Apotheme (Gr. ἀποτίθημι, *I deposit*). A term applied by the old chemists to some of the varieties of extractive matter.

Apotome (Gr. ἀπότομος). In Geometry, a term employed by Euclid and some of the ancient mathematicians to denote the remainder or difference between two lines or quantities commensurable only in power. Thus, if from the diagonal of a square a part equal to the side of the square be cut off, the remainder is the apotome, and is represented numerically by the expression $\sqrt{2} - 1$. In the tenth book of his *Elements*, Euclid divides apotomes into six classes.

Apozem (Gr. ἀπόζεμα, from ἀπό, and ζέω, *to boil*). An old Pharmaceutical term for a decoction.

Appalachian Chain. The name of the principal mountain range of Eastern North America, separating the great plains of the interior of the continent from the eastern plains bordering the Atlantic. The chain includes, in all, from three to five parallel ridges of mountains from 3,000 to 4,000 feet high, separated by longitudinal valleys. Known as the Alleghany chain in the states of Virginia and Pennsylvania [ALLEGHANIES], they continue towards the north-east into Canada, being crossed by the valley of the St. Lawrence.

Apparent (Lat. appareo). A term used in Astronomy to denote things as they appear to the eye, in distinction to what they really are. Thus, the apparent altitude of a star denotes the angle which its line of vision makes with the horizon; but the real altitude is found by making a correction for the effects of refraction, which, in all positions except the zenith, causes the star to appear a little higher than it would if there were no atmosphere. The apparent diameter of a planet is measured by the angle made by two straight lines drawn from the eye to opposite points of its disk; the real diameter is a straight line joining those points; while astronomers call the angle under which the diameter would be seen from the centre of the earth, the true diameter. The apparent or sensible horizon denotes the plane which is a tangent to the earth's surface at the place of the observer; the true horizon is a plane parallel to the former, and passing through the centre of the earth. Apparent motion is the velocity and direction

in which a body appears to move to an observer who is himself in motion. For example: the apparent diurnal motion of the stars from east to west arises from the rotatory motion of the earth, which carries us along with it in an opposite direction. Apparent time is the same as true time, or the hour indicated by the sun's passage over a meridian; while mean time is that which would be indicated by the sun if its apparent angular velocity were uniform.

Apparent Heir. In Law. [HEIR.]

Apparent Solar Day. The interval between two successive transits of the sun's centre over the same meridian. It begins when the centre is on the meridian.

Apparitor (Lat.). Among the Romans, attendants on judges and magistrates, appointed to receive and execute their orders. In English Law, a messenger of the Spiritual Courts of Law, so called from his duty of summoning persons to appear.

Appeal (Lat. appello, *I call*). In Law, 1. The removal of a cause from an inferior court to a superior. 2. An accusation of a criminal offence by one subject against another. The bringing decisions of the courts of Scotland and Ireland, or of the court of chancery in England, before the house of lords, is peculiarly termed an appeal in the first sense. Criminal appeals are now obsolete; those on charges not capital have long been so. Appeals of treason and of felony subsisted for a much longer period: the latter had doubtless their origin in the early jurisprudence of the Gothic nations, by which acts of violence or injury were redeemable by a weregild or fine to the party injured or his nearest relative. They were put an end to by stat. 59 G. III. c. 46. [WAGER OF BATTLE.]

Appearance. In Law, the act whereby a defendant in an action recognises the process by which that action is commenced against him: originally by appearing in person, or by attorney, in court; now, by filing common or special bail to a writ of capias, by delivering a memorandum in writing to an officer of the court, in answer to a writ of summons, &c.

Appellant. In Law, the party by whom an appeal is made; as against an order of magistrates to the quarter sessions, or against the decision of a court of equity to the house of lords. The opposite party is termed respondent.

Appendage (Lat. appendix). In Botany, all parts which are regularly arranged round any other part are called appendages. Thus leaves are appendages of the axis; so are all the parts of a flower theoretically. The supernumerary sepals in a strawberry are appendages of the calyx; the abortive stamens that arise from the calyx of a passionflower are appendages of the calyx; and so on.

Appendiculate. Having appendages. The word is sometimes applied to all those plants which are furnished with leaves or appendages of the axis.

Appendix (Lat.). In Literature, a supplement added at the end of a work, either to contain portions of the subject which had been omitted, or separate pieces and extracts from other works bearing on it. The latter are termed in French *pièces justificatives*.

Appensus (Lat. participle of appendo, *I hang up*). When an ovule is not exactly pendulous, but is attached to the placenta by some point intermediate between the apex and the middle.

Appentis (Fr.). The name given in works upon Architecture to a species of lean-to roof supported upon columns, or brackets, let into the wall to which it is desired to afford a protection.

Appian Way. The most celebrated of the highways leading from ancient Rome. It was constructed by the censor Appius Claudius, A.U.C. 442; and commencing at the Porta Capena, now the gate of St. Sebastian, it extended to Capua, the then limit of the territory of the republic. It was formed of stones, squared and jointed and laid in mortar, and was made wide enough to allow two carriages to pass one another abreast. On each side was a ditch, for the purpose of removing the surface-water falling upon the road.

Apple (Anglo-Sax. apl, Ger. apfel). The cultivated fruit of *Pyrus Malus*, the crab apple of our hedges. All the numerous varieties that are now so common are said to have originated slowly from improvements of this wild sort. At what period its amelioration commenced is unknown; but, as Pliny was acquainted with several kinds, it is reasonably to be supposed that its improvement is to be assigned to a high antiquity. If it could be true that pippins, that is, seedling improved apples, were introduced only at the end of the sixteenth century, we should have to give the southern nations of Europe the credit of having furnished us with the stock from which the valuable varieties we now possess have been derived. Dr. Prior has, however, lately pointed out that the probable origin of the apple is eastern, and that the garden apple is not, as usually supposed, an improved crab, but the crab a degenerate apple. It was apparently the only fruit with which our ancestors were acquainted before they came into Europe; for with the exception of a few wild berries and the hazel nut, it is the only one for which we have a name that is not derived from the Latin or French. 'The meaning of the word,' continues Dr. Prior, 'is unknown; but as *ap* is in Zend and Sanskrit "water," and *p'hala* "fruit," we might be tempted to believe that it originally meant water-fruit or juice-fruit, with which the Latin *pomum*, from *po*, to drink, exactly tallies.' There is no doubt that apples of some kind have been known in England from long before the Conquest, and although they may have been of bad quality, and fit for food only when roasted, yet they could hardly have failed to produce seedlings of valuable qualities. The term apple is employed in composition to designate any large fleshy fruit, as love-apple, thorn-apple, pine-apple, &c.

Appogiatura (Ital. from appogiare, *to lean upon*). In Music, a small note preceding a larger one of greater duration, of which it borrows a portion of its value.

Apportionment. In Law, the dividing of a rent, &c. into parts, according to the number and proportion of the parties between whom the land is divided.

Appraisement. The valuation of goods sold under distress for rent due, by sworn appraisers, under several statutes. [DISTRESS.]

Apprehension, simple. In Logic, is that act or condition of the mind in which it receives a notion of any object, and is said to be either incomplex or complex: the former being the apprehension of one object, or of several without any relation between them, as 'a man,' 'cattle;' complex, of several, with such a relation, as 'a man on horseback,' 'a herd of cattle.'

Apprentice (Fr. apprendre, *to learn*). A person bound by indenture, for a certain term, to perform services for a master, receiving, in return, instruction in a trade or occupation, and, in most instances, necessary food and clothing. Apprenticeship seems to have originated, together with guilds and fraternities, in the middle ages. Seven years is a common term of apprenticeship in Germany, as well as in England; but other periods, as three and eight, have been customary in different trades, places, and times. The former period was fixed in England by the statute 5 Eliz. c. 4, which regulated apprenticeship throughout the realm in general. By 54 G. III. c. 96, persons were allowed to exercise their respective trades without having served; London, and a few other corporate towns, being excepted. Apprenticeship is, therefore, now only recognised by the law as the mode of learning a trade. The better protection of apprentices was provided for in 1851 by stat. 14 & 15 Vict. c. 11.

Approach, Curve of. In Geometry, the name given to a curve which possesses this property—that a heavy body descending along it by the force of gravity, makes equal approaches to the horizon in equal portions of time. It was proposed by Leibnitz, and its properties investigated by Bernoulli and others.

Approver. In Law, a person who, being indicted of treason or felony and not disabled from giving legal evidence, upon his arraignment, before any plea pleaded, confesses the indictment, and takes an oath to reveal all treasons and felonies that he knows of, and therefore prays a coroner to enter his appeal or accusation against those that are his partners in the crime contained in the indictment.

Approximate (Lat. approximo, *I draw near to*). In Zoology, when the teeth are so arranged in the jaws, that one passes on the side of the next, and there is no intervening vacancy or diastema. The disposition of the teeth in the human species and in the *Anoplotherium* forms an example.

Approximation (Lat. proximus, *nearest, next to*). A drawing near to. In Mathematics, quantities are said to be approximate which are nearly but not absolutely equal.

In a general sense, the term approximate may be applied to every result of natural philosophy or experimental science. For example, the magnitude of the earth, the distance of the sun, the masses of the planets, in fact, all the elements of astronomy, are only known approximately, and that in consequence of the imperfections of our senses and the errors of our instruments. In mathematics, too, quantities are frequently investigated which, from their very nature, are not susceptible of accurate numerical determination. We have then recourse to methods of approximation, by means of which the values of such quantities can be ascertained to any required degree of accuracy.

Thus, the diagonal and side of a square being incommensurable, we can only determine the length of the former, in aliquot parts of the latter, approximately. The perimeter of a polygon inscribed in a circle is always less than the circumference of the latter, but approximates the more thereto the greater the number of sides. In general, too, we may say that all magnitudes which increase or decrease by insensible degrees are incapable of exact expression by numbers, from the fact that the latter increase discontinuously, in other words by units.

Again, in the extraction of roots, the solution of algebraical equations of a degree higher than the fourth, and in general in all inverse operations where, the *process* and *result* being given, the subject operated upon is required, approximation is our only resource.

The method of exhaustion, by which the ancient mathematicians attempted to find the rectification and quadrature of the circle, was the first instance of a systematic method of approximation. The indivisibles of Cavallieri effected the same object in a more rapid and general manner, and prepared the way for the differential calculus. The invention of the method of infinite series led immediately to general methods of approximating to the values of all radical quantities, and subsequently to the roots of all kinds of compound equations whatever. Vieta was the first who showed how to find successive values of the roots of equations, each approaching more nearly to the true value than the preceding; but his method was tedious and imperfect. Other methods, more easy and general, have been given by various mathematicians; among which, the best known are those of Newton, Halley, and Raphson, and those which have been proposed at a later period by Lagrange, Legendre, Budan, and others. These methods are in general drawn from the most abstruse parts of the theory of equations, and could not be explained in this place with the details necessary to render them of any use. For the best information on the subject, we may refer the reader to the excellent work of Lagrange, 'Traité de la Résolution des Equations Numériques;' the

'Nouvelle Méthode pour résoudre les Equations Numériques' of M. Budan; the 'Supplément à l'Essai sur la Théorie des Nombres,' by Legendre; and the article *Equations*, in the Encyclopædia Britannica, by Mr. Ivory. [EQUATIONS.]

Apricot (Lat. præcox, *early*, or Arab. berkhach, *butter fruit*). The fruit of *Armeniaca vulgaris*, a native of Kashmir, and probably of the mountains of Cabul, and distributed from Persia and the Oases of Egypt throughout the temperate parts of the world. In its wild state the apricot is a small round pale waxy yellow fruit, rosy on one side, and agreeably subacid: in that state it is dried in large quantities under the name of mishmish. In its most improved state it becomes three times as large and sweeter, but it is then apt to become insipid. For the confectioner's purpose, the Brussels and Breda apricots, which are near approaches to the wild fruit, are better adapted than the larger and sweeter kinds. For the history of the word, see Wedgwood, *Dictionary of English Etymology*, s. v.

April. The fourth month of the year. The name is probably derived from Lat. aperire, *to open*, either from the opening of the buds, or of the bosom of the earth, in producing vegetation.

A priori (Lat.). In Philosophy and Rhetoric, is a phrase somewhat loosely applied to designate a class of reasonings. It is generally understood to apply to any argument in which a consequent conclusion is drawn from an antecedent fact, whether the consequence be in the order of time, or in the necessary relation of cause and effect;—e.g., 'The mercury sinks, therefore it will rain.' This is an argument drawn from an antecedent in time, not from a cause to an effect. A murder has been committed; a party falls under suspicion, as having had an interest in the death of the deceased, or a quarrel with him: this suspicion is founded on the argument *à priori*, from cause to effect; because the fact of his enmity or interest would afford a cause for his committing the murder. On the other hand, another party falls under suspicion, as having been seen to quit the house at a particular time, having marks of blood on his clothes; these are arguments *à posteriori*, in which we reason either from consequent in the order of time to antecedent, or from effect to antecedent cause. The famous *à priori* argument of Clarke and others in favour of the existence of a God, was an argument drawn from certain primary axioms in metaphysics; while the common course of reasoning to prove the same truth from the visible proofs of design in the works of nature, is an instance of the latter or *à posteriori* form.

Apron (Fr. naperon). A piece of lead let into a wall to form the gutter of any portion of a building; it is also placed under the cills of windows or doors, or projections on a roof. It is likewise applied to the planks that are laid at the entrance of a dock; or to the enclosure of brick or of stone inserted at the down side of a waterfall produced by a lock, or by a cross wall, from the overflow of a pond of still water impounded on the upper side of the dam. The security of an hydraulic work of this description depends very much upon the resistance of the apron wall, and great care is required in its execution to prevent the effects of undermining or of overthrow.

Apse. [ABSIS.]

Apsidal Surfaces. A surface derived from a given one by setting off upon all radii vectores through an assumed origin lengths equal to the normals (apsidal radii) from that origin to the section of the given surface determined by a plane through the origin perpendicular to the radius vector. Such surfaces consist, in general, of a number of distinct sheets, corresponding to the number of normals that can be drawn to any section. The best known surface of this class is the Wave Surface of Fresnel, which is derived from an ellipsoid by setting off upon every central radius vector lengths equal to the semi-axes of the central section perpendicular to that radius. Interesting papers on surfaces of this class will be found in *Mémoires de l'Institut*, vol. vii.; *Transactions of the Royal Irish Academy*, vol. xvi.; *Quarterly Journal of Mathematics*, vol. iii.; Crelle's *Journal*, vols. lii. and liv.; *Annali di Matematica*, vol. ii. &c.

Apsides, or Apses (Gr. ἀψίς, *circle*, or *curvature*). The two points of the orbit of a planet or satellite, at which it is moving at right angles to the straight line joining it with the primary. These two points of the orbit are the two extremities of the major axis, or the points at which a planet is at its greatest and least distance from the sun. The point at the greatest distance is called the higher apsis; that at the least is called the lower apsis: consequently, the higher apsis corresponds with the aphelion, and the lower apsis with the perihelion. The line joining these two points, which is the major axis of the orbit, is called the line of the apsides. It has a slow angular motion in the plane of the planet's orbit; and the time which the planet employs in completing a revolution with regard to its apsides is called the anomalistic period. [ANOMALY; APHELION.]

Aptenodytes (Gr. ἀ, priv., πτηνός, *winged*, δύτης, *a diver*). A genus of diving web-footed Natatorial birds, peculiar to the antarctic shores, having wings too short for flight, covered with short stiff feathers, resembling scales, and used as fins or paddles for swimming under water. The legs are short, thick, set far back, with four toes, all turned forwards, three of them long and webbed, the fourth very short. The bill is longer than the head, straight, and slightly curved at the tip; nostrils in the upper part of the bill, concealed in front by feathers. The Patagonian penguin is the representative of the genus.

Apterans, Aptera (Gr. ἄπτερος, *wingless*). A term including a proportion of the class of insects, the value of which varies in different systems of Entomology. In the Lin-

næan system it is the seventh order of insects, distinguished by their having no wings. Kirby makes his Aptera the twelfth order of the class of insects, but acknowledges that it is not a natural one, and limits the definition of it to those insects which are apterous, or never acquire organs of flight. In Latreille's last system, aptera is no longer applied to designate an order of insects.

Apterous. In Botany, denotes any part of a plant which is destitute of membranous expansions. The term is usually employed in distinction to alate, or winged.

Apteryx (Gr. ἀ, priv., πτέρυξ, *a wing*). A genus of birds represented by three or perhaps four species, natives of New Zealand, in which the wings are reduced to a single defensive spur.

Aptychus. A name applied to the operculum of *Ammonites*. It was supposed to be a bivalve shell, as it was composed, like the 'hood' of the *Nautilus*, of two elements, not, however, fibrous and confluent, but calcified and united by a straight suture. The discovery of the operculum *in situ* by Mr. S. P. Woodward, F.G.S., has removed all doubts as to its affinity. It is also termed Trigonellites.

Apus. A name applied by Scopoli to a curious genus of Entomostracan Crustacea, characterised by a flattened, semitransparent, membranous envelope, which protects the body like a shell, having a deep cleft posteriorly; and bearing in front two large eyes, placed close together, with a third smaller one behind. The first pair of legs are long, filamentary, and branched, representing antennæ; the remaining sixty pairs are short, compressed, and modified so as to form a respiratory organ; according to the structure which characterises the Branchiopodous, or gill-footed order, to which the Apus belongs. The species of Apus appear in immense numbers in our freshwater pools; they prey chiefly on tadpoles; and some attain the length of an inch and a half.

Apyrexia (Gr. ἀπυρεξία, *absence of fever*). The intermission of feverish disorders.

Apyrous (Gr. ἄπυρος, from ἀ, priv., and πῦρ, *fire*). A term formerly applied to substances which resisted a strong heat without change.

Aqua (a Latin word, found under modified forms in almost all languages of the Aryan family of nations). Water. It is often almost Anglicised, as in the words aquavitæ, aquafortis, aquamarine.

Aqua ardiente (Sp.). An alcoholic drink made in Mexico from the fermented juice of the Agave.

Aqua fortis (Lat.). Nitric acid.

Aqua regia (Lat.). A mixture of nitric and hydrochloric acids, so called from its power of dissolving gold, the king of the metals.

Aqua Toffana. [Aquetta.]

Aquæductus (Lat.). In Anatomy, the term is applied to certain canals leading from the labyrinth or internal ear to the outside of its bony capsule or os petrosum: one of these, which extends from the hinder part of the vestibule to the posterior margin of the petrosal, is called 'aquæductus vestibuli;' a second canal, leading from the cochlea to the jugular fossa of the petrosal, is called 'aquæductus cochleæ.' The function of the 'aqueducts' is unknown.

Aquamarine (Lat. aqua marina). The name under which are comprised varieties of Beryl of clear transparent tints of sky-blue or sea-green. The Aquamarine is used in jewelry, and was known to the ancients as the Beryl. [Beryl.]

Aquarians. In Ecclesiastical History, a title given to sectaries in the early church who insisted on the use of water instead of wine in the celebration of the Eucharist.

Aquarium. More properly *Aqua-vivarium*. A receptacle in which live animals are preserved, in fresh or in salt water, the latter being either transmitted from the sea, or artificially prepared. The art of aquarian preservation has been improved lately throughout Europe, and the Zoological Society of London now have a series of aqua-vivaria in their gardens in the Regent's Park.

Aquarius (Lat.). *The Waterbearer.* The eleventh sign of the zodiac, through which the sun moves in part of the months of January and February. Also, one of the twelve zodiacal constellations.

Aquatic plants. Plants which grow in water, which may be either running or stagnant. In the former case they are called river plants: in the latter, pond plants. Such as grow in the sea are called marine plants.

Aquatinta engraving (Lat. aqua, *water*, and tincta, *dyed*). A mode of etching, by which an effect is produced similar to that of an Indian-ink drawing.

Aquatics, Aquatilia (Lat. aquaticus). A name applied by Nitzsch to an order of birds; by Cuvier to a family of Mollusks; by Latreille to a division of Crustacea; by Lamarck to a family of bugs (*Cimicidæ*); each of which groups includes animals which live in, swim on, or frequent the margins of waters.

Aqua vitæ (Lat. In Fr. *Eau de vie*). The name absurdly given to brandy and other intoxicating liquors.

Aqueduct (Lat. aquæductus). A term used to express any artificial channel for conducting water; but, generally speaking, it is applied to such buildings as serve to lead the water across a valley, by means of a bridge aqueduct.

The aqueduct of Appius Claudius was the most ancient of those constructed for the supply of Rome, and it is said to have been opened for public use about the year 442 A.U.C. It conveyed water to the city from a distance of between seven and eight miles, by a deep subterranean channel of more than eleven miles in length. The aqueduct of Quintus Martius was a more extraordinary structure. It commenced at a spring thirty-three miles distant from Rome, made a circuit of three miles, and then, forming a vault of sixteen feet diameter, it ran thirty-eight miles along a

series of arches, at an elevation of about seventy English feet above the surrounding country. The upper part of this aqueduct was composed of three channels, placed one above the other, and serving to conduct the water from three distinct sources. In the uppermost flowed the *aqua Julia*; in the second, the *aqua Tepula*; and in the third, or the lowest, the *aqua Martia*; all of which, of course, distributed their waters at different levels. The *aqua Virgo*, constructed by Agrippa, who seems also to have erected similar works in the province of Gaul, passed through a tunnel 800 paces in length. The *aqua Claudia*, begun by Claudius, and finished by Nero, conveyed the water from a distance of thirty-eight miles to the capital. It formed, for thirty miles of its length, a subterraneous stream, and was supported on arches for a distance of about seven miles; and so perfectly were the works executed that it continues to supply the town at the present day. The waters of the river Anio were also conducted to Rome by two different channels; the first was carried through an extent of forty-three miles, and the latter through upwards of sixty-three miles, of which six miles and a half formed one long series of arches, many of them upwards of 100 feet in height. Nine great aqueducts existed in Rome at the commencement of the reign of Nerva; five others were commenced by that emperor, under the superintendence of Julius Frontinus, the conservator aquarum; and it appears that at a later period the number amounted to twenty. The supply of water furnished by these different works was enormous. According to the enumeration given by Frontinus, the nine earlier aqueducts delivered every day 14,018 quinaria, which corresponds to 27,743,100 cubic feet. We may therefore assume that the total supply was equal to 50,000,000 cubic feet of water; and if the population of ancient Rome be taken at one million, which perhaps it never exceeded, this would furnish a supply of fifty cubic feet of water for the daily consumption of each individual. It is, however, to be observed that the requirements of the baths and the naumachiæ rendered the conditions of supply very different from those which prevail at the present day in English towns, where the quantity of water distributed is the nearest to that which prevailed in Rome.

The remains of some Roman aqueducts in other parts of Europe give evidence of the existence of works on quite as magnificent a scale as those of ancient Rome itself. Of these the aqueduct of Metz was one of the most remarkable, and a great number of its arches still remain. It extended across the Moselle, a river of considerable breadth at this place, which it traversed upon a series of arches, and conveyed the water of the river Gorse to the city of Metz. The water was received in a reservoir, from whence it was conducted by subterraneous channels, formed of hewn stone, and so spacious that a man could walk upright in them. The arches appear to have been fifty in number, and fifty feet in height in the loftiest part; some of the middle ones have been swept away by the flow of ice down the river, but the land arches still remain. The aqueduct of Lyons is perhaps the most curious of these monuments, as it seems to furnish some proof that the ancients only erected the huge bridges for conducting their water from one side of a valley to the other, in consequence of the deficient state of the arts of metallurgy in their days. The aqueduct of Lyons, in fact, contained a reversed syphon in its length, which caused the water to descend, and mount again, 164 feet, in a distance of 2,640 feet; the pipes in this case were lead, and they served to conduct the water from the upper reservoir to a lower one, from whence the flow was resumed. This work effectually disposes of the assertion that the ancients did not know the existence of the hydraulic law, before referred to, of the tendency of water to assume its level in the two branches of a reversed syphon. The aqueduct of the Pont du Gard at Nismes, and that of Segovia in Spain, may also be cited as specimens; of this description of construction in antiquity they are both of them still standing in all their beauty and grandeur, and are good specimens of the care the masters of the ancient world bestowed on these works. The first serves to conduct the stream of the Gardon to the town of Nismes, and it consists of three ranges of arches, the two lower ones being of considerable span; the other has two rows of arches, one above the other, and the height of the edifice is about 100 feet, passing over the roofs of the houses in the city. In Constantinople there are the remains of some aqueducts of a debased style of construction; and in Africa there are the relics of a perfect system of this style of construction.

Aqueducts have been constructed in modern times which rival those of Rome in grandeur; especially in France, where the mania for works of imperial magnificence still survives. One of the most remarkable of these was the projected aqueduct of Maintenon, begun by Louis XIV., under the direction of Marshal Vauban, for the purpose of leading to Versailles the waters of the Eure; it was to have been about 4,400 feet long, and about 200 feet high, and after having cost the lives of many hundred soldiers, and countless treasure, it was abandoned when the first row of arches was turned. The aqueduct of Arcueil, for the supply of Paris, was erected previously to this one, by Jacques de Brosses; and after it we may mention the execution of the Montpellier aqueduct, and more recently still the Pont de Roquefavour, as specimens of French skill in this style of construction. In Italy, the aqueduct of Spoleto is a strange specimen of the application of the pointed arch to this usage; the aqueduct of Caserta is a bold structure for the same purpose; and the aqueduct of Genoa is an illustration of the attempts of engineers to throw off the tyranny of their Roman predecessors in this matter, for

it comprises in its length a syphon bridge in the same style as that of Lyons. The aqueduct of the Prince Biscari in Sicily, and that of Lisbon, are good specimens of modern works for carrying aqueducts on a level at a considerable height; the latter has even been said to have been a Roman construction, but there are authentic documents in existence to prove that it does not date beyond the year 1760. The last aqueduct erected for the carriage of a stream of water across a valley in the style of the ancient Romans was the Harlem river aqueduct, on the New York waterworks, which is, after all, nothing more than a bridge of 100 feet in height over the Hudson.

Upon the lines of the canals there have been erected some important aqueducts for the purpose of supporting the water-way at the level once fixed, and also for the conveyance of streams of water for irrigation purposes. Of these works it may be worth while to mention the Irwell, the Scottish Midland Canal, the Lune, the Pont y Cisilte, and the Ellesmere aqueducts, the Guettin and the St. Florentin, the Ganges and the Godavery irrigation canals, all of which are distinguished by a boldness of design and a hardiness of construction which place them in a distinguished position in their class. The introduction of cast-iron pipes, which has only taken place within the last century, has, it may be added, superseded the necessity for this expensive style of structures for the main purpose for which the ancients used them.

Aqueous humour. A thin watery fluid holding in solution a small quantity of chloride of sodium and extractive matter, situated in a space behind the cornea of the eyeball, which is divided into an anterior and posterior chamber by a musculo-membranous partition called 'iris,' perforated by the aperture called 'pupil.' The chief use of the aqueous humour is to maintain the convexity of the cornea and support and facilitate the movements of the iris.

Aqueous rocks. Rocks evidently derived from the action of water. All varieties of bedded limestones, sandstones, and clays, all rocks consisting of water-worn pebbles mixed with sand and other foreign substances derived from the natural wearing away of a coast by water, are assumed to be aqueous rocks, without other evidence. Those which contain fragments of marine or freshwater animals, or fragments of vegetable matter accumulated with them in regular layers, have clearly been formed under water; and, generally, wherever material has arranged itself in beds or layers with any degree of regularity, this is the only reasonable explanation of their condition.

The term 'Aqueous rocks' thus includes the whole series of fossiliferous rocks in all parts of the world, besides many rocks buried with and included amongst them that are not fossiliferous. Among the rest volcanic ash is not uncommon in certain localities; and when transported by water, although of volcanic origin, it must be regarded as an aqueous rock.

Almost all aqueous rocks are also so far changed from their original condition as to deserve being regarded as *metamorphosed*. They, therefore, very often pass into METAMORPHIC ROCKS, by a series of gradations which renders it impossible to define where one begins and the other ends. Thus, limestones pass from the state of mere mechanical accumulations containing shells and bones, into close compact limestones, where the appearance of shells is exceptional; and thence they pass into crystalline marble. So sandstones pass into quartzite, and clays into slate. Probably, also, many of the true porphyries are only further steps in the same direction. The term *aqueous rocks* is therefore only definite when the origin of the rock is clear.

Aqueous rocks are grouped into various subdivisions in different countries, the divisions having more or less value according to the evidence of fossils. [DESCRIPTIVE GEOLOGY.]

Among metamorphosed rocks those that are *aqueous* are contradistinguished from the *igneous*. The steps by which they pass into each other are further described in the article on METAMORPHISM. Many of the marbles and slates that are altogether crystalline still contain, if they do not consist of, shells, corals, and other remains of the inhabitants of the water beneath which the rock was originally accumulated.

Aquetta (Ital. *little water*). A celebrated poison used by the Romans during the pontificate of Alexander VII. It was probably a preparation of arsenic, and was also known under the name of *aqua Toffana*, from a woman of the name of Toffana, or Tofania, who prepared it at Naples.

Aquifoliaceæ (Lat. aquifolius, *with pointed leaves*). A natural order of Exogens, connecting the monopetalous with the polypetalous subclasses. The whole of the species are either shrubs or trees, and scattered over most parts of the world. *Ilex*, *Prinos*, and *Cassine* are the commonest genera.

Aquila (Lat. *an eagle*). The genus of Accipitrine or Raptorial birds, including the eagles proper, or those species of the Linnæan *Falco* which have no trenchant tooth and corresponding notch in the beak.

AQUILA. In Astronomy a constellation above, and adjacent to, Capricornus and Aquarius.

Aquila alba (Lat. *the white eagle*). An alchemical name of *calomel*. The old chemists designated sal ammoniac and other sublimates by the term aquila.

Aquilariaceæ. A very small order of Indian plants, secreting a fragrant resin. They are included amongst rhamnal Exogens, and are also allied to *Thymelaceæ*. The species are but little known. The *Aquilaria Agallochum* is the tree that produces the eagle or aggul wood, and which, in all probability, was the aloes wood of Scripture.

Aquilegia. A genus of Ranunculaceous plants remarkable for the curious structure of their flowers, which have five petals pro-

duced backwards, into long hollow tubes either straight or curved inwards towards the axis. The petals look something like a cornucopia turned upside down. They are herbaceous perennials, with ternately divided leaves, and are known commonly under the name of Columbine.

Arabesque (Fr.). This is a term applied to a species of ornament, capricious, fantastic, and imaginary, consisting of scrolls of fruits, flowers, and other objects; it was practised by the ancients at a very early period. Foliage and griffins were by no means unfrequent in the friezes of temples, and are seen on many of the ancient Greek vases, and on the walls at the baths of Titus, at Pompeii; and in many other places elegant examples of this species of decoration are to be found. It is, however, to Raphael and Giulio Romano that we owe the most splendid specimens of this style in painting.

The term Arabesque is a corruption, from the supposed Arabian origin of the style. But pure Saracenic ornament has nothing in common with the Italian arabesque of the fifteenth and sixteenth centuries, originally derived from the antique. The purest examples are to be found in the Venetian monuments of the Lombardi and other cinquecento sculptors, consisting of floriated scrolls and figures perfectly executed. The Vatican arabesques of Raphael are occasionally more grotesque, and less æsthetic in their details. In later work, in the so-called Renaissance arabesque, the cartouche or shield is the prominent ornament, which in France, and more especially in the time of Louis XIV., degenerated into a mere play of light and shade, in variations of the scroll and shell which eventually became the Rococo of Louis XV. See Wornum's *Analysis of Ornament or Characteristics of Styles*, 2nd ed. 1861.

Arabin. That variety of gum-exudation from the bark of trees which is soluble in water. Gum-arabic is the common type of such gums.

Arabo-tedesco (Ital. arabo, *Arabic*, and tedesco, *German*). In Painting and Sculpture, a style of art composed of Moorish and Gothic mixed, such as is often found in Venice and the north of Italy. The term is nearly obsolete, and is almost synonymous with Byzantine.

Araceæ or **Aroideæ** (Arum, Egypt. *aron*, *one of the genera*). Acrid Endogens, with the flowers arranged upon a spadix, enclosed within a spathe. In hot countries they sometimes become arborescent; in many cold countries they are unknown. Most commonly they arise from a fleshy underground tuber, from which an eatable fæcula is procured by washing away the acrid matter. Their flowers are almost destitute of floral envelopes: the sexes are mostly placed in different flowers, and their embryo has a slit on one side. *Caladium seguinum*, now generally referred to *Dieffenbachia*, the dumb cane of the West Indies, derives its name from its juice paralysing the muscles of the mouth, if chewed; nevertheless, the leaves of certain *Caladiums* are eaten by the negroes like spinach, but they require to be boiled in several waters, and are too acrid for an European palate.

Arachidic acid. A solid crystalline matter contained in the oil expressed from the seeds of the *Arachis hypogæa*, a Brazilian plant.

Arachin. A fat composed of arachidic acid and glycerin.

Arachis (Gr. ἀ, priv., and ῥάχις, *a chine or back-bone*). A genus of *Leguminosæ*, having the common property of thrusting its fruits into the ground before maturation: hence they are called earth-nuts, or ground-nuts. *A. hypogæa*, a native originally of the West Indies, is now cultivated in all warm climates, the seeds, of the size of peas, being eaten, and also yielding a large quantity of oil, which forms a substitute for that of olives.

Arachnidans, Arachnida (Gr. ἀράχνη, *a spider*). A class of Apterous, spider-like Condylopods, having the head confluent with the chest, and the body consequently consisting of but two segments, with eight legs, smooth eyes, and the sexual orifices situated on the thorax, or anterior part of the abdomen.

Arachnoid (Gr. ἀράχνη, *a spider*, and εἶδος, *form*). Cobweb-like. An Anatomical term, applied to the tunic of the vitreous humour of the eye, and to the thin membrane placed between the dura and pia mater of the brain.

Aræostyle (Gr. ἀραιόστυλος). In Architecture, the style of intercolumniation in which the distance between columns is made equal to four, and sometimes to five, diameters: the former is, however, the distance to which the term is strictly applied. It is principally adopted for the Tuscan order; rarely to any other.

Aræosystyle. In Architecture, that style of building in which columns are arranged in pairs, with an interval, generally of half a diameter, between the coupled columns, and of three diameters and a half between the pairs. This arrangement produces a bad effect when the length of the façade is not great.

Aragonite. A peculiar kind of carbonate of lime originally found in the province of Aragon in Spain. It is harder than the common variety, has a higher specific gravity, and crystallizes in hexagonal prisms instead of in rhombohedral forms. A little carbonate of strontia is frequently a constituent of Aragonite; some specimens contain as much as 4 per cent. of carbonate of strontia, and more rarely from 2 to 4 per cent. of carbonate of lead: water is, also, generally present. It is found in Buckinghamshire, at Torbay in Devonshire, in Cumberland, and in many other localities, and is sometimes (as at Carlsbad) deposited by hot springs, and forms the incrustations in the boilers of steam-engines. 'Carbonate of lime crystallized from cool solutions takes the form of calcite, but if their temperature exceed 150° it will become aragonite. On the other hand, crystals of aragonite heated by a spirit lamp, decrepitate and fall into powder, which consists of grains having the form of calcite.' (Jukes,

Manual of Geology, 2nd ed. p. 26.) This powder, however, is stated by Gustave Rose to be strictly amorphous. [For varieties of Aragonite, see FLOS FERRI, SATIN SPAR, and MOSSOTITE.]

Arak, Arack or **Arrac.** An alcoholic drink made in Tartary from fermented mare's milk.

Araki. An intoxicating liquor made in Egypt from dates.

Araliaceæ (Aralia, *one of the genera*). An order of Exogens, differing in little from the Apiaceous or Umbelliferous plants, except in having more than two parts in their fruit. They are commoner in hot than in cold latitudes, and form a transition from *Apiaceæ* to *Vitaceæ*. The only wild examples of them in Europe are the diminutive *Adoxa Moschatellina*, and the Ivy, *Hedera Helix*. The celebrated Rice-paper plant of the Chinese is the *Aralia papyrifera*.

Aralo-Caspian region. A great depression in that part of the old world which lies between Europe and Asia, and is separated by the mountains of the Caucasus from the Black Sea and the Mediterranean. This large tract is still covered partly with water, as it contains the great basin of the CASPIAN SEA, which, with the Sea of Aral, collects part of the drainage of the great plains of Asia. The whole district is one of the most interesting points in the physical geography of the Old World. The low flat lands now occupying the intervals between the two great inland seas of the Caspian and the Aral, form part of the *steppes* of western Asia [STEPPES], and are below the level of the waters of the Atlantic. The depression of the Caspian below the Black Sea is about 83 feet. The Caspian is separated from the Sea of Aral by the plateau of the Ust-Urt; and the level of the waters of the Sea of Aral, though not clearly made out, is believed to be much higher than that of the Caspian. Owing to the number of streams entering the Caspian Sea, and its comparatively small depth, its waters are not so salt as those of the Mediterranean. That the Caspian and Aral waters have formerly extended very widely to the north, and that they were at one time connected, is rendered clear by the nature of the rocks in all the vast plains that extend in several directions from them. The recent deposits on the plateau of the Ust-Urt are, however, oceanic.

The present area of the Caspian is about 24,200 square miles, and of the Sea of Aral 4,500 square miles. The depth of the Caspian is believed not to exceed 600 feet in its deepest part, and it is generally much more shallow. The Aral Lake is not so deep as the Caspian. The whole Aralo-Caspian region occupies not less than 100,000 square miles. The two lakes are rapidly filling up by miscellaneous deposits brought in by the numerous rivers that enter into them. Of these the Volga is the principal.

On the whole, there can be no doubt that a great internal sea of brackish water formerly spread over all the low country between the Caspian and Aral seas, covering the present desert of Khivah, and extending far away to the east and south, ranging northward through large portions of the Kirghis steppes into Siberia. This district, when it was separated from the Black Sea and the Mediterranean, did not contain any large quantity of salt water, and the flow of fresh water from the great streams that enter it is amply sufficient to prevent any increase of saltness.

Araneidans, Araneidæ (Lat. aranea, *a spider*). A tribe of the Pulmonary order of Arachnidans, with a coriaceous integument; modified antennæ, or chelicera, consisting of a single joint armed with a claw, perforated near the apex for the transmission of venom: breathing by pulmonary apertures, which are either two or four in number, with the abdomen pedicellate, and the arms provided with four or six spinnerets.

Araneosus (Lat. aranea, *a spider*). Covered with hairs crossing each other like the rays in a spider's web.

Arar. The Barbary name of *Callitris quadrivalvis* (*Thuja articulata*), the tree whose wood is chiefly used by the Mahometans of Africa for the construction of their mosques. Its resin is the sandarach of commerce.

Araucaria (Araucanos, *a tribe of Indians in the southern parts of Chili*). A genus of noble fir trees with very rigid branches, having leaves like scales, either small and sharp-pointed, or stiff, spreading, and lanceolate. The cones consist of leaves something like those of the stem, only longer, and containing large seeds. Two species occur in South America, and others in New Holland, Norfolk Island, and New Caledonia.

Arbalest (Lat. arcubalista, *a cross-bow*). This weapon is supposed to have been introduced into European armies by the crusaders, although used long before in the chase (in England as early as the reign of William the Conqueror). The arrows used with the cross-bow were short and thick (quarrels, bolts). The weapon was used in the English armies after the reign of Richard I.; but the Italians, and especially the Genoese, were most expert in the use of it at one time. A large force of Genoese cross-bow men served in the French army at Cressy, where their weapon was found very inadequate to match the English long-bow. Yet so deadly a weapon was it at one time considered, that papal bulls were issued in the twelfth century, condemning and forbidding its use in combats between Christians. It was disused in England, as a weapon of war, in the reign of Henry VIII. Cross-bows were of several sizes: the large or stirrup cross-bow was bent by the foot.

Arbitration (Lat. arbitratio, from arbiter, *an umpire*). In Law, the investigation before an unofficial person or persons of the matters in difference between contending parties. The judgment is called an award. The reference to arbitration may be made, whether

legal proceedings concerning the question referred have been instituted or not. [AWARD.]

Arbogast's method or calculus of derivations. The principal object of this method may be stated, in general terms, to be the development of any function of a given polynomial in a series arranged according to the powers and products of the variables which this polynomial contains. Taylor's series is the simplest example of such a development, the polynomial in question being there merely a binomial. Arbogast, the inventor of the method, was a professor of mathematics at Strasburg at the close of the last century, at which place his great work entitled *Calcul des Dérivations* was published in 1800. This work, besides giving a solution of the above problem, is remarkable as containing a first attempt at a calculus of operations. The principle of the separation of symbols of operation from those of quantity, which principle has since thrown so vast a light on mathematics in general, is there for the first time practically applied.

Arbor Dianae (Lat.). *The tree of silver*, that metal having been called Diana by old chemists; it is made by putting quicksilver into a solution of nitrate of silver, which causes the separation of the silver in a beautiful arborescent and crystalline form.

Arbor vitae (Lat.). An evergreen tree or large shrub, of which several species are found in our gardens. They belong to *Thuja*, a genus of *Coniferae*.

Arboreous (Lat. arboreus). Woody: plants whose stems take a ligneous character are called suffrutescent, or arboreous, according to the degree of woodiness which they exhibit. Plants which grow on trees are also sometimes called arboreous, such as the arboreous lichens, arboreous mosses, arboreous fungi, &c.

Arborescent (Lat. arboresco, *to become a tree*). Those stems of plants which are at first herbaceous, and afterwards become somewhat woody and tree-like.

Arboriculture (Lat. arbor, *a tree*, and colere, *to cultivate*). The art of cultivating trees and shrubs, which are chiefly grown for timber or ornamental purposes. The culture of trees and shrubs grown for their fruits as food, is included under horticulture, and is sometimes called Pomology. The origin of arboriculture may be traced to the progress of agriculture; because, as population increased in any given country, it would become necessary to clear away the natural woods in order to grow corn and other products of the field and garden. After this was done to a certain extent, a scarcity of wood, both for fuel and building purposes, would be found, and then recourse would be had to artificial plantations—Arboriculture. This art may be considered almost exclusively one of modern times; because, though the Greeks and Romans planted both timber and ornamental trees, yet they did so only on a very limited scale, and near their houses, for the purposes of shade or ornament. They also planted the elm and the poplar, for supports to their vines; and they cultivated osier beds for the purposes of basket-making, but there is no instance on record of their having planted trees with a view of cutting them down either for timber or fuel. Wood for these purposes they procured from the native forests, to the management of which they paid particular attention. In Britain, the first plantations of barren timber on a large scale, with a view to profit, were made during the reign of Henry VIII.; and the kind of tree planted was chiefly the oak, which was raised from the acorn where it was finally to remain. Since that period, the formation of artificial plantations has been on the increase, more especially during the latter end of the last and the beginning of the present century, when the foreign supply of timber was comparatively limited by the war, and when there was a great demand for timber for ship-building. The discovery of coal mines, and more especially the increased facility of working them after the invention of the steam-engine, by providing fuel exclusive altogether of wood, has rendered the necessity of preserving natural woods, and of forming artificial plantations, less in Britain than in any other country in the world. In consequence of this, there is no other country in which so small a portion of its surface is covered with forests; the woods being almost everywhere planted and maintained for ornamental purposes. On the continent of Europe, the practice of sowing or planting barren timber was little known before the time of Louis XIV., though the natural woods both of France and Germany were appropriated, and carefully preserved, for many generations before. At the present time, in consequence of the continental nations depending almost entirely on wood for their fuel, the care of the natural forests, and the formation of artificial plantations, form an important part of the duties of government. In North America, in the oldest cultivated parts of the country, the formation of artificial plantations is barely commencing, while in the back settlements, or newest parts, the felling and clearing of timber is only now taking place.

The science of Arboriculture depends on a knowledge of the nature of trees, of the different agents in cultivation, and of the purposes to which trees are applied in the arts. The practice includes nursery culture: viz. propagation by seeds, by cuttings, layers, grafting, &c., and raising in beds and rows; transplanting, pruning, thinning, and, finally, felling, and the succession of kinds. The nursery culture is carried on in limited spots, called nursery grounds, or nursery gardens, by gardeners or nurserymen; and the other operations in woods, groves, rows, hedgerows, hedges, copses, osier holts, &c., by foresters, woodmen, or hedgers.

Arbustum (Lat.). The classical name for an orchard, hopyard, or vineyard.

Arbutin. A crystalline body contained in the *Arbutus* or *Arctostaphylos Uvae-ursi*.

Arbutus (Lat.). A genus of evergreen Ericaceous trees, with pitcher-shaped pallid flowers, and a bullet-like succulent austere

fruit, rough externally, and containing numerous minute seeds. Several species, all hardy, are known in gardens; the most common of which is *Arbutus Unedo*, the most beautiful *A. Andrachne.*

Arc (Lat. arcus, *a bow* or *arch*). In Geometry, denotes a portion of a curved line. The right line joining its extremities is called its *chord*. Theoretically, the length of an arc is given by the integration of the expression $\sqrt{dx^2 + dy^2}$, after x and y have been expressed as functions of a single variable by means of the equation to the curve. [RECTIFICATION.] Practically, this length may be determined by dividing the original arc into sufficiently small parts, and finding the sum of their chords.

Arc boutant (Fr.). A term sometimes used in Architecture, to express what is technically called a flying buttress. [FLYING BUTTRESS.]

Arca. The name of a genus of Acephalous Mollusca, characterised by a bivalve and equivalve shell, having numerous sharp alternate teeth at the hinge. In modern systems the genus is raised to the rank of a family (*Arcadæ*), subdivided into the subgenera *Arca, Cucullæa, Pectunculus*, and *Nucula.*

Arcade. In Architecture, this term is applied to a series of arches, crowned with a roof or ceiling, with a vault or passage underneath the same. The piers of arcades may be decorated with columns, pilasters, niches, and apertures of various forms. The arches are turned, sometimes with rockworked, and sometimes with plain rustic arch-stones, or voussoirs, springing from an impost or platband, and sometimes, though this course is not to be recommended, from columns. They usually have a keystone carved in the form of a console, or sculptured with some device. Scamozzi made the size of his piers less, and varied his imposts and archivolts in proportion to the delicacy of the orders he employed; but Vignolles made his piers always of the same proportion.

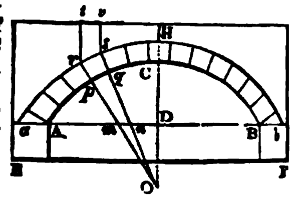
Arcanite. A Mineralogical synonym for Glaserite [which see].

Arcanum (Lat. *a secret*). A term often applied to Chemical and Medical preparations by the old philosophers. Thus they called red oxide of mercury, obtained by the action of nitric acid, Arcanum corallinum: sulphate of potash, Arcanum duplicatum, &c.

Arceuthida (Gr. ἄρκευθις, *a juniper berry*). A small cone (strobilus) whose scales become succulent, and grow together into a fleshy ball: it is the same as Galbulus.

Arch (Lat. arcus, *a bow*). In Anatomy, a structure commonly composed of bone or other hard material disposed in a bow-like form, and constituting the chief part of the primary segment of the skeleton: that which rests upon the body of the vertebra (projects backward in man), and spans across the neural axis or trunk of the nervous system, is called the 'neural arch;' that which is suspended in an inverted position (extends forward in man), and encloses the hæmal axis (heart and vascular trunks), is called the 'hæmal arch.' Those in the segments composing the head are called, with their surrounding soft parts in the embryo, 'visceral arches.' Curved portions of the great arterial and intestinal tubes are called 'arches,' as the 'arch of the aorta,' the 'arch of the colon.'

ARCH. In Building, a structure of stones or bricks, or distinct blocks of any hard material, disposed in a bow-like form, and supporting one another by their mutual pressure. In describing arches some technical terms are made use of, which it will be convenient to define. The arch itself is formed by the voussoirs, or stones cut into the shape of a truncated wedge, the uppermost of which at C is called the keystone. The seams or planes in which two adjacent voussoirs are united, are called the joints; the solid masonry, A E and B F, against which the extremities of the arch abut or rest, are called the abutments; and the line from which the arch springs at A a B b, the impost. The lower line of the arch stones, A C B, is the intrados or soffit; the upper line, the extrados or back. The beginning of the arch is called the spring of the arch; the middle, the crown; the parts between the spring and the crown, the haunches. The distance A B between the upper extremities of the piers, or the springing lines, is called the span, and C D is the height of the arch.



There is considerable difficulty in determining the form which an arch ought to have, in order that its strength may be the greatest possible, when it sustains a load in addition to its own weight; in fact, the determination cannot be accurately made, unless we know not only the weight of the materials the arch has to support, but also the manner in which the pressure is connected; that is to say, unless we know the amount and direction of the pressure on every point of the arch. Supposing, however, that the arch has to sustain only its own weight, and supposing, further, that the friction of the arch-stones is reduced to nothing, a relation between the curve and the weight of the voussoirs may be found by comparing the pressures which are exerted on the different joints. Thus the pressure on any joint, $s\,q$ for example, arises from the weight of that portion of the arch which is between $s\,q$ and the summit C H. Now, the portion of the arch C q s H is sustained by three forces: the pressure on the joint $s\,q$, the pressure on C H, and its own weight. Let $s\,q$ be prolonged till it meets C D in O, and let n be its intersection with A B. It is a theorem in statics, that when a body is held in equilibrium by three forces balancing each other, these forces are proportional to the three sides of a triangle

formed by lines respectively perpendicular to the directions of the forces. The three forces sustaining C q s H are, therefore, proportional to the sides of the triangle O D n; for the pressure on s q acts in the direction perpendicular to s q or O n; the pressure on C H is perpendicular to D O, and n D is perpendicular to the direction of gravity. The pressure on s q is, therefore, to the pressure on C H as n D to D O. In like manner, the voussoir p r q s being so shaped, that r p, when produced, meets O H in the point O; the pressure on the joint r p is to that on C H, as m D to D O. Hence, the pressure on s q is to the pressure on r p as D n to D m. We are thus led to infer that the voussoirs ought to increase in length, from the key-stone to the piers, proportionally to the lines D n, D m, &c.: for in this case, the surfaces of the joints being increased in proportion to the pressure they sustain, the pressure on every point of the arch will be equal. It will also be observed that the angle n O D is equal to the angle made by a tangent to the curve at q, and the horizontal line parallel to A B; the angle m O D equal to that made by the tangent at p and the horizontal line; and the radius D O remaining constant, D n is the tangent of the first of these angles, and D m of the second; hence the pressures on the successive joints are proportional to the differences of the tangents of the arches reckoned from the crown. From this property, when the intrados is a circle given in position, and the depth of the key-stone is given, the curve of the extrados may be found. When the weights of the voussoirs are all equal, the arch of equilibration is a catenarian curve, or a curve having the form which a flexible chain of uniform thickness would assume if hanging freely, the extremities being suspended from fixed points.

Such is the form which theory shows to be the best adapted to give strength to an arch, on the supposition that there is no superincumbent pressure. But it seldom if ever happens that this is the case, and therefore it is entirely unnecessary, in the actual construction of an arch, to adhere closely to the form determined on the above supposition. Indeed, on account of the friction of the materials and the adhesion of the cement, the form of the arch, within certain limits, is quite immaterial, for the deviation from the form of equilibration must be very considerable before any danger can arise from the slipping of the arch-stones. The Roman arches, which have resisted the attacks of time for so many centuries, are generally in the form of a semicircle. For bridges, it is better to employ a smaller segment of a circle; frequently the elliptic arch is preferred, on account of the beauty of its form.

It has not been satisfactorily ascertained in what country arches were first erected. They do not occur in any of the buildings of the Egyptians that can unquestionably be referred to an ancient date; and if they were not altogether unknown to the Greeks before the period of the Roman conquest, their principal uses appear to have been very little understood. They do not appear ever to have been employed in roofing the temples, or to have formed a part of ornamental architecture. By the Romans, however, the advantages of the arch were well understood at a very remote period. The Cloaca Maxima, which is an arched structure, is referred to the age of the Tarquins; the arched dome is supposed to have originated with the Etruscans, and to have been employed for the convenience of the augurs, affording them a shelter from the weather, and permitting them at the same time to have a view of the whole range of the horizon. In the magnificent buildings erected under the empire the arch is of frequent occurrence; and it was by the Romans that it was first applied to its most useful purposes, namely, the construction of bridges and aqueducts. The Romans, however, appear to have given little attention to the graces of form in the erection of their arches, for they seldom deviated from the semicircle. It was in the middle ages that the pointed or Gothic arch was introduced, when Christians and Saracens vied with each other in giving beauty to their public buildings, by multiplying and combining arches in all possible manners. The associated architects of those ages, says Dr. Robison (*Ency. Brit.* art. 'Arch'), having studied this branch of the art of building with so much attention, were able to erect the most magnificent buildings with materials of which a Greek or Roman architect could have made little or no use. There is infinitely more scientific skill displayed in a Gothic cathedral than in all the buildings of Greece and Rome; indeed, these last exhibit very little knowledge of the mutual balance of arches, and are full of gross blunders in this respect; nor could they have resisted the shock of time so long, had they not been almost solid masses of stone, with no more cavity than was indispensably necessary. It is somewhat remarkable that those architects do not appear ever to have studied or paid any regard to the theory of equilibrated arches. The form which they adopted was strong, and capable of resisting considerable inequalities of pressure, and hence the durability of their constructions. [BRIDGE; DOME.]

Archæology (Gr. ἀρχαιολογία, from ἀρχαῖος, *ancient*, and λόγος, *a description*). The science or study of Antiquities, and chiefly, in ordinary language, of those minor branches of antiquities which are discarded from the contents of general history: as genealogies, national architecture, manners, customs, heraldic and similar subjects.

Archæopteryx (Gr. ἀρχαῖος, and πτέρυξ, *wing*). A name originally given by Hermann von Meyer to the fossil impression of a feather which has been found on the two opposite surfaces of a split slab of the Solenhofen (oolitic) slate. This cannot be distinguished from the feather of a bird; and birdlike feathers

have also been found attached to the bones of a singular animal, in which the metatarsals are trifid, and the carpal bones support a divergent fan of feathers. Another fan of feathers was attached to the long, many-jointed tail. The structure of the head is unknown.

Archæus (Gr. ἀρχαῖος, from ἀρχή, *principle*). A term used by the old chemists and physicians to imply the occult cause of certain phenomena. Van Helmont and Stahl ascribe certain vital functions to the influence and superintendence of a spiritus archæus.

Archaism (Gr. ἀρχαϊσμός). In Rhetoric and Literature, the use of an obsolete expression or phrase, giving an air of antiquity to the passage in which it occurs.

Archangelica. A genus of *Umbelliferæ* nearly related to *Angelica*. The whole plant is powerfully aromatic. *A. officinalis*, the garden angelica, is a tall-growing biennial, whose leaf-stalks, formerly eaten like celery, are now employed by confectioners in the composition of sweetmeats.

Archangels (Gr. ἀρχάγγελος). A superior order of angels. The term occurs once in Scripture, being applied by St. Jude to Michael.

Archbishop (Gr. ἀρχιεπίσκοπος). The primate of a province containing several dioceses. The term first came into use in the fourth century, and was first employed by Athanasius.

Archdeacon (Gr. ἀρχιδιάκονος). An ecclesiastical officer, ranking next to the bishop. His functions were at first confined to attending upon and assisting the bishop in the discharge of his spiritual duties and the management of his diocese, and had at first no jurisdiction. There are now more archdeacons than one in each diocese, the whole number in England being sixty; and they are employed by their bishops in visiting the clergy of the diocese, and in the dispatch of other matters relating to the episcopal superintendence.

Archduke. A title originally assumed by various dukes, but in the sequel appropriated to those of the house of Austria by the Emperor Frederic III. in 1453. It is now strictly confined to the younger sons of an emperor of Austria.

Archegosaurus (Gr. ἀρχηγός, *beginning*, and σαῦρος, *lizard*). This is a genus of Ganocephalous Reptiles, which has been discovered in the coalfields of Bavaria and Westphalia. It presented the same retention of embryonic characters as the *Lepidosiren*, having, like that animal, a persistent notochord, and ossification restricted to the arches and peripheral vertebral elements. The ossified occipital condyles which characterise the skull in better developed *Batrachia* were absent in *Archegosaurus*. Its teeth exhibited folds of cement introduced from the periphery into the substance of the tooth, analogous to the structure in *Lepidosteus*. The under-surface of the body between the head and trunk is defended by broad bony plates, homologous with the median and lateral large throat plates of various highly organised fishes, e.g. *Megalichthys* and *Sudis gigas*.

Archencephala (Gr. ἀρχη, and ἐγκέφαλος [sc. μυελός], *the brain*). The highest division of the class *Mammalia*, to which the order *Bimana* composed of the solitary genus *Homo* (*nosce te ipsum*) belongs. This subclass is distinguished from the other divisions by the enormous vertical and posterior development of the cerebral over the cerebellar lobes, forming what is termed 'a third lobe,' in which are found structures termed by anatomists posterior *cornua* and *hippocampi minores*, complications of the cerebral substance hitherto undiscovered in any other Mammalian. The human brain is further distinguished from the inferior *Mammalia* by the greater size of the cerebral mass, the larger horizontal extent of the *corpus callosum*, and the absence of the lateral perpendicular fissure. With these physiological characters is associated a psychological development, which has raised the human races to their present state of intellectual supremacy.

Archer (from the Latin arcus, *a bow*). A bowman; one who uses a bow. The use of the bow in war may be traced to the earliest antiquity, and to the history of almost every people. The exact time when the English long-bow began to be used in war is not exactly ascertained: the Normans brought with them the arbalest or cross-bow; but from the reign of Edward II. the long-bow, the favourite national weapon, seems to have been fully established. When fire-arms began to come into use, various attempts were unsuccessfully made, by statute and proclamation, to prevent this ancient weapon becoming obsolete. In France the officers who attended the lieutenant of police were, before the Revolution, always called archers, although provided with carbines.

Arches, Court of. The supreme court of the Archbishop of Canterbury, the judge of which is called the Dean of the Arches, because his court was anciently held under the arches of Saint Mary-le-Bow, in London. It is now held in Westminster Hall. The appeal from this court is to the Judicial Committee of the Privy Council.

Archetype (Gr. ἀρχέτυπος, from ἀρχή, *origin*, and τύπος, *type*). The original of that which is represented in a picture or statue. In the language of Plato, it means the world as it existed before creation in the mind of God. [TYPE.]

ARCHETYPE. In Anatomy, is that ideal original or fundamental pattern on which a natural group of animals or system of organs has been constructed, and to modifications of which the various forms of such animals or organs may be referred. The archetypal figure has been most clearly recognised in the study of the modifications of the skeleton of the vertebrate animals. [VERTEBRA.]

Archil (a corruption of Fr. orseille). A kind of purple dye obtained from the lichens

called *Roccella tinctoria* and *fuciformis*. It is chiefly procured in the Canaries.

Archimandrite. A title of the Greek Church, equivalent to abbot; the word mandra signifying a *monastery* in the language of the Lower Empire.

Archimedian Screw. A tube wound round a cylinder revolving obliquely. It is an ingenious and primitive method of raising water to small heights, and may still be seen at work in the Netherlands.

Architectural Geology. To the architect and builder a knowledge of rocks is especially necessary, in reference to foundations, to the nature of the material employed, and also as to facilities for natural and artificial drainage. These all depend strictly on geological position. Architectural geology, however, strictly so called, is so nearly the same as engineering geology, and both involve so many similar questions with regard to material, that it will be best to consider BUILDING MATERIALS separately, and refer to ENGINEERING GEOLOGY for remarks on rocks available for foundations, and as affecting buildings upon them. DRAINAGE is also the subject of a separate article. [See also CEMENTS and PLASTERS and the various articles on STONE.]

It does not often happen to the architect to select the site for buildings to be constructed, and thus one very important application of geology in reference to public and private buildings is frequently neglected. A sufficient supply of pure wholesome water is a matter that ought of all others to be secured for every habitation, but this also is too often forgotten till too late.

Architecture (Lat. architectura, from Gr. ἀρχιτέκτων, *an architect*). The art of Building, according to certain proportions and rules determined and regulated by nature and taste. Architecture becomes an art at that period only in the history of nations when they have reached a certain degree of civilisation, of opulence, and of luxury. In an earlier state, it can only be reckoned among the trades or occupations necessary to the wants of mankind: its application is then very limited, its use simply furnishing man with shelter. At its birth, however, it assumes in all countries a character which in the sequel stamps it with such remarkable and distinguishing features, that in its grandest developments the traces of its early origin are still discernible. Notwithstanding the interval of so many ages from its origin, we may even trace the general form of architecture to three distinct states of the human race, which necessarily influenced the nature of the habitations suitable to each, and which ultimately became standard models of the art.

People whose dependence for their sustenance was on hunting and fishing, from the natural indolence induced by those occupations and the little industry called for in such courses of life, would not be soon led to construct dwellings. They availed themselves of the natural caverns of the rock, or at most hollowed them out, for shelter and protection.

Nations occupied in a pastoral life, through a large portion of the year, obliged, for the sake of fresh pasturage, frequently to change their abode, and thus to lead a wandering life, would wish to remove their dwellings with themselves; hence the use of tents.

Agriculture, which requires continued and active industry on the same spot, doubtless induced man to exert his energies in the erection of solid and durable dwellings. They were necessary for his produce no less than for himself, and the wooden hut with its sloping roof was the offspring of his wants.

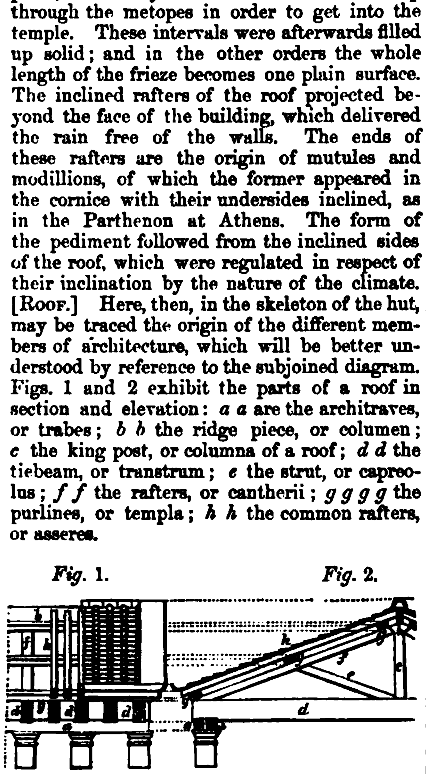
It is not, however, to be understood that in every country the art can be traced to a single principle, since among some nations, as will hereafter be seen in relation to Egyptian architecture, more than one will be found to enter into the combination. Causes, independent of the habits of the people, may have had their influence on the formation and taste of different species of architecture; yet these in their turn will be found dependent on the first named. In short, it is to the three states of mankind that we must refer, if we wish to account for those striking peculiarities which prevent us from confounding the art of one people with that of another. In some of its details caprice may have had a share; but in every country the great leading forms spring from principles dependent on the different states of life just enumerated.

Those who have sought for the original types of this art in subterraneous temples and excavations exclusively, have fallen into error. These are found in almost every country. Many of them, such as the famous Ear of Dionysius at Syracuse, had been the quarries that furnished stone for their neighbourhoods.

The wooden hut which has been erroneously assumed as the type of all styles of architecture, was unquestionably the model of Grecian architecture. The Greeks, working upon this, transferred to stone the forms of an assemblage of carpentry, a construction which gave birth to the members of what are technically called the orders of architecture. This style, it must be remembered, belongs to a nation whose chief occupation is agriculture. In pursuing this theory, a few remarks only will be needed. The first trees driven into the earth for the purpose of bearing a covering for shelter, were the origin of the insulated columns of the portico of a temple, and became one of the most splendid features of the art. As the trees were wider in diameter at the bottom than the top, so were the columns diminished in thickness as they rose. Scamozzi, a pupil of Palladio, imagined that the mouldings at the bases and capitals of columns had their origin in cinctures of iron, to prevent the splitting of the timber; others, however, think that the use of the former was to elevate the shafts from the dampness of the earth, and thereby prevent rot. The architrave or chief

beam speaks its origin. It was the great beam placed horizontally on the tops of the columns, and destined to receive the covering of the entire building. The joists of the ceiling lay upon the architrave, the space in height which they occupy being called the frieze, the ends of the joists in the Doric order bearing the name of triglyphs, from their being sculptured with two whole and two half glyphs or channels. Sometimes the ends of them are sculptured into consoles, as in the composite order of the Coliseum at Rome. The space between the triglyphs was for a long period left open, as we find from a passage in the *Iphigenia* of Euripides, where Pylades advises Orestes to slip through the metopes in order to get into the temple. These intervals were afterwards filled up solid; and in the other orders the whole length of the frieze becomes one plain surface. The inclined rafters of the roof projected beyond the face of the building, which delivered the rain free of the walls. The ends of these rafters are the origin of mutules and modillions, of which the former appeared in the cornice with their undersides inclined, as in the Parthenon at Athens. The form of the pediment followed from the inclined sides of the roof, which were regulated in respect of their inclination by the nature of the climate. [ROOF.] Here, then, in the skeleton of the hut, may be traced the origin of the different members of architecture, which will be better understood by reference to the subjoined diagram. Figs. 1 and 2 exhibit the parts of a roof in section and elevation: *a a* are the architraves, or trabes; *b b* the ridge piece, or columen; *c* the king post, or columna of a roof; *d d* the tiebeam, or transtrum; *e* the strut, or capreolus; *f f* the rafters, or cantherii; *g g g g* the purlines, or templa; *h h* the common rafters, or asseres.

Fig. 1. *Fig.* 2.



It has been suggested, but with less probability, that the main supports being by degrees placed at greater distances from each other than the strength of the architrave would safely admit, inclined struts were placed from the sides of the columns or supports to the underside of the architrave, to lessen its bearing, and that these gave the first notion of the use of arches in architecture. The subject has been pursued into many more details, on which our limits do not permit us to enter.

The Doric order, doubtless the earliest of the orders, remains without testimony which can satisfactorily assure us of the period of its invention. But by the time of Alexander the Great the three original orders of architecture had been brought to perfection. Moral as well as physical causes had contributed to bring the arts to this state. In the period preceding the Peloponnesian war, there was a general burst of talent in Greece. It was in this age that the Greeks commenced the rebuilding of the temples and edifices that had been destroyed in the Persian war. This was the epoch of a pure and grand style of architecture, and, indeed, of art generally. The sculpture of that period is marked by the same character of purity, sublimity, and grandeur; and the Elgin marbles, now possessed by this country, exhibit a perfection which has never been approached by modern art, and which we scarcely conceive can be surpassed. It was in this age that the temple of Athena (known by the name of the Parthenon) was erected,—a building which displays, perhaps, the finest model of the Doric order.

The Ionic order seems, at this period, to have likewise received the finishing touches of the grace and elegance of which it was susceptible. This order seems, in the enervating climate of Asia Minor, to have acquired elegance at finish at the expense of solidity. Wheth[er] we are indebted for its invention to the peop[le] whose name it bears, or whether its origin is be traced to Assyria, is of little importan[ce]. Upon the relation of Vitruvius no depende[nce] can be placed. At the period, however, of t[he] erection of the temple of Athena Polias [at] Athens, which was about the time we ha[ve] referred to, it seems to have been brought to [a] state of perfection. The capitals of this e[x]ample are splendid specimens of decorated [ar]chitecture.

By a substitution of acanthus leaves for t[he] olive, laurel, and lotus leaves of the Egypt[ian] capital, Callimachus is said to have inve[nted] the Corinthian capital, the feature which d[is]tinguishes the Corinthian from the Ionic ord[er]. The tale seems an idle one; but though als[o] threadbare, we cannot omit it, and will giv[e it] in the words of the author who has recorded [it]. 'A Corinthian maiden fell a victim to a viol[ent] disorder. After her interment, her nurse, [col]lecting in a basket those articles to which [she] had shown a partiality when alive, carried th[em] to her tomb, and placed a tile on the bas[ket] for the longer preservation of its contents. [The] basket was accidentally placed on the root [of] an acanthus plant, which, pressed by the wei[ght], shot forth, towards spring, its stems and la[rge] foliage, and in the course of its growth reac[hed] the angles of the tile, and thus formed vol[utes] at the extremities. Callimachus, happenin[g at] this time to pass by the tomb, observed [the] basket, and the delicacy of the foliage w[hich] surrounded it. Pleased with the form [and] novelty of the combination, he constructed, f[rom] the hint thus afforded, columns of this spe[cies] in the country about Corinth, and arrange[d its] proportions, determining their proper meas[ures] by perfect rules.'

The annexed diagram gives a representation of the circumstance, as usually found in architectural works; the reader, however, is at liberty to make his own representation of it, which will most probably be as near the truth as that which is here given.

Not many examples of the Corinthian order are extant of so early a date as the age of Alexander. Its delicacy and slenderness render it very susceptible of the ravages of time; and it has been suggested, that the value of the material of which the columns and capitals of this order were made, excited the cupidity of the Romans to remove them.

Rome appears to have been indebted to the people of Etruria for its earliest work of any note. It has been supposed that the construction of the immense sewer which drained the city, and in which might be discerned a presage of its future grandeur, is the work of an Etruscan dynasty which existed in Rome in prehistoric times. The genuine architecture of Rome was that of the arch; the Greek forms in their later buildings are simply the result of a passion for imitation. The patronage of Augustus drew the most skilful Grecian artists to Rome, which now became the capital of the world. It was under Augustus that Vitruvius wrote his work on architecture, the only ancient text-book on the art that has reached us. Under Agrippa, the son-in-law of Augustus, the Pantheon was raised: one of the most magnificent examples of Roman grandeur. Amongst other superb structures he introduced baths, and constructed a considerable number of fountains, aqueducts, &c. Under the successors of Augustus, the public buildings of the nation continued to increase; but the art began to degenerate in the reigns of Tiberius, Caligula, and Claudius. It could not be expected that it would revive under such a personage as Nero, who deprived the finest statues of their heads to substitute his own bust on their shoulders. He was, however, a great encourager of buildings on a highly decorated and colossal scale; witness the Domus Aurea built for him by Severus and Celer. The wisdom and greatness of character of the emperor Trajan were infused into the buildings of his reign. The triumphal arches, but especially his column and forum, incontestably prove the state of the art under his auspices, at which time his architect, Apollodorus, who raised the column to his memory, was highly patronised. It was not long, however, before the art began to decline. The arch of Septimius Severus betrays an extraordinary falling off; and it is difficult, in such a short period, namely, from the reign of Marcus Aurelius, to conceive how the art of sculpture, more especially, could have become so debased. The details of what is called the goldsmiths' arch indicate the decline of good taste; its profiles are bad, and the ornaments overloaded.

For a short time architecture was prevented from entirely sinking by the fostering hand of Alexander Severus; but the fall of the western empire completed its ruin: it is, however, from the reign of Gallienus, whose arch proves to what a state it was reduced, that we must reckon the total extinction of the arts. Architecture was indeed most likely to have survived the general wreck, and perhaps was not completely involved in the universal ruin. In an age when no sculptor existed, the baths erected by Diocletian exhibited a grandeur manifest even in their stupendous remains. The palace at Spalatro is another proof of the enormous efforts made by that emperor, and of what the art could then do. About the same time or in the time of Aurelian, were erected the extensive buildings at Balbec and Palmyra: vicious as they are in taste, we are astonished at the vastness of the plans, the boldness of the undertaking, and the funds lavished on their construction.

Though architecture, from various causes, was destined to survive the other arts, its protracted existence could not extend beyond the period of the removal of the seat of empire to Byzantium. The endeavours of Constantine to erect his city into a metropolis that should rival Rome, which he spoiled of its treasures, were vain. That which Constantine left behind him in the eternal city and the rest of Italy fell a prey to the fury of the Visigoths. The edifices which they afterwards reconstructed were from fragments of buildings which they had destroyed. The columns which the ruins supplied were used as piers for arcades. Quatremère de Quincy attributes (*Enc. Method.*) the use of the arch springing from columns to the ignorance of the builders of the period, who knew not, he assumes, the mode of connecting the different lengths of an architrave; but it seems scarcely probable that they, who so well knew the mode of connecting the voussoirs of an arch, should have been deficient in understanding the principle in question, which is either that of the arch itself or of the simplest joggling. From this period to the time of the Renaissance all sight of the original types seems to have been lost; and in the end arose a style, under the name of Gothic, which will be separately treated of. But in Italy the old traditions never altogether lost their force. The church of St. Mark at Venice rose in the tenth or eleventh century; it was the work of Greek architects, and is invaluable in tracing the history of architecture. In 1013 the Florentines laid the foundations of the church of S. Miniato; but the most extraordinary monument of the period was the cathedral at Pisa, erected by Buschetto da Dulichio, a Greek architect, in 1016: this building is lined both inside and outside with marble, and the roof is borne on four ranks of columns of the same material. The commerce of the Pisans enabled them to explore the Levant, the islands on the coast of Asia Minor, Egypt, and Africa, for the most costly and precious marbles which were used in the work. Painters and sculptors were brought from Greece to embellish their

buildings, and these contributed to strengthen a taste to which the forms of Gothic art had never been congenial.

In the thirteenth century the church of the Virgin of Assisi was erected in Tuscany, and the castel da Ovo at Naples; the first by Lapo, and the last by Fucio, both Florentines. Nicolo da Pisa, their countryman and cotemporary, was employed on several important edifices in Bologna, Padua, and Venice. His greatest works are the churches at Padua, of St. Anthony and of the Holy Trinity at Florence. Arnolpho di Lapo built the church of Sta. Croce, and designed the cathedral at Florence. All the cities of Italy, indeed, at this epoch seemed to be emulous of outvying each other. Paolo Barbetta was engaged at Venice on the church of Santa Maria Formosa; many works were in progress at Bologna; the marble chapel of the church of Santa Maria Maggiore at Rome, about the year 1216, was executed by Marchione: every effort indicated the speedy revival of classical design. These efforts, however, were confined to Italy; in the other parts of Europe the Gothic style continued to prevail until the Reformation checked the progress of church building.

In Italy architecture was fast reverting to classical ideas. John of Pisa, son of the Nicholas whom we have just mentioned, was employed by his townsmen on the Campo Santo. This public cemetery was in the Gothic style, and is remarkable for the elegant simplicity of its plan and the beauty of its details. It is a singular link in the chain of architectural history: there is no difficulty in discerning the struggle in the mind of the architect to free himself from those Gothic shackles which seemed to hang on it as an impediment to an immediate return to the classic taste of the land. The troubles throughout Europe were stilled at the time when Brunelleschi was called on to finish the cathedral of Florence, of which the octagon had not been covered by Arnolpho and Giotto. Of Arnolpho's ability to cover this space with a dome there can be little doubt; but it would have been a dome ornamented with three or four tiers of galleries externally. 'It appears, however, that in the beginning of the fifteenth century a less expensive or more classical form of dome was demanded, but no one seemed to know exactly how to set about it. Under these circumstances Brunelleschi went to Rome, and studied with the most intense enthusiasm not only the dome of the Pantheon and all the other vaults which the Romans had left in that city; but, becoming enamoured of his subject, he mastered every detail of the style, and became familiar with every form of Roman art. In the year 1420 he returned to his native city, thoroughly a classic in all that referred to architecture; and not only did he, after innumerable complications, complete the great object of his life before he died, but he left his mark on the architecture of the age.' We have quoted the words of Mr. Fergusson, in his recently published *History of Modern Architecture* (p. 41), because no other writer has so clearly shown that the earlier period of the Renaissance approached very nearly to a genuine revival of art, while in its later phases it soon passed into mere copying. This tendency to imitation, apart from original thought, is betrayed in some designs by Brunelleschi himself. In the church of the Holy Spirit at Florence the classical details are used, as Mr. Fergusson remarks, with singular elegance and purity; but between the piers and the spring of the arch is inserted a fragment of entablature, which in this church has not even the excuse that it is repeated on the wall. 'It is, however, worthy of being remarked here as the earliest instance of the use of one of the typical forms of the Renaissance, which is, taking it all in all, perhaps the most fatal gift of classic art to modern times, as nine-tenths of the difficulties and clumsinesses of the revived art are owing to the introduction of this feature. The first thing the architects of the fifth and sixth centuries did was to abolish this fragment of an entablature, and place the arch direct on the pier or pillar where it ought to be; and the advantage of this proceeding is so self-evident that it seems strange that it could ever have been restored. No single feature can more clearly mark the dawn of copying, to the exclusion of thought, than its reproduction.'

For the influence which this revival of classical design and ornamentation exercised on the countries of Northern Europe, we must refer the reader to Mr. Fergusson's *History of Modern Architecture*. He may be right or wrong in considering Gothic imitations or reproductions worse than classical imitations; but he has traced with the utmost exactness the downward course of the art from the earliest period of the Renaissance, and his chapters on the revived classical design in France and England are especially worthy of attentive study.

Architecture, *Chinese*. As a description of the buildings of China would be out of place in a work of this nature, the subject of the present article is confined to a general view of the principles, the character, and the taste of Chinese architecture.

In China the rise of the arts seems to have been constantly repressed by the state of mechanical drudgery and servitude in which the people are kept. In their painting, for example, the most exact imitation of plants, fruits, and trees, is thought indispensable. Every matter relating to building is the subject of regulation by the police, which, rather than theory, governs its architecture. The laws of the empire detail and enforce with the greatest precision the mode of constructing a lou or palace for a prince of the first, second, or third rank, of a grandee, of a mandarin, &c. According to the ancient law of the kingdom, the number and height of the apartments, the length and height of a building, are all regulated with precision, from the plain citizen to the mandarin, and from the latter up to the emperor himself.

Herein alone we have sufficient to account for the poverty and want of invention in Chinese art.

In speaking of the principles of Chinese architecture, the word is not applicable in the same way as when we speak of classical architecture, but is meant to apply to those primitive causes which gave birth to it. Character and taste in every species of architecture are the necessary results of these elements. There can be no doubt that the tent is the real model of all Chinese buildings. One of the strongest proofs of this fact is the form of the Chinese roof. Nothing but a tent or pavilion could have given the idea of it. Again, there is nothing like the appearance of a member of wood, similar to our architrave, destined to lie on the tops of the columns, and receive and support the remainder of the carpentry. The Chinese roofs, on the contrary, jut out beyond the columns, whose upper extremity is hidden by the eaves: hence the omission of the use of capitals. It is easy to perceive that extreme lightness must result from this imitation. The spirit and character of tents carried into the construction of cities might, at least in reality, be lost and altered by a change of materials. The semblance of lightness might be found in union with essential solidity of construction; the character would have been intellectually the same. Here, however, identity of material has contributed to the identity of the copy with the original. Among the Greeks, whose model was carpentry, the change from wood to stone soon removed the appearance of weakness and lightness that was found in the model. In China the material remains the same, and its architecture of wood still copies the model of wood; hence, the lightness of the original is transferred to the copy. It should, however, be remarked that Mr. Fergusson, whose opinion must carry very great weight on all subjects of Eastern architecture, holds that the model followed by the Chinese was not the tent, but the Buddhist *tee*, or termination at the apex of Buddhist temples in India. This consisted of a square box, in stone, representing undoubtedly the original wooden *châsse* or relic-box surmounted by an umbrella, which, having also been originally of wood, was afterwards worked in stone. Sometimes three umbrellas were placed one over the other; and when, following the ordinary course of development, they came to be copied in stone, a more complete architectural character was given to them, until at last they assumed something of a spirelike form, such as is that of the Chinese pagoda. (See Fergusson's *Handbook of Architecture.*) But, to say the least, however great may have been the zeal with which the Chinese embraced Buddhism, it seems strange that a mere piece of detail, insignificant in size, however important in its uses, should have been taken as the type of whole buildings and repeated with astonishing perseverance and uniformity; for the model which originated the pagoda originated also the whole domestic architecture of China.

Lightness is the essential character of Chinese architecture; but there is another characteristic quality, both of the model and the copy, that is observable in the edifices of China; and this is its gay appearance. In this respect scarcely any style presents a more pleasing effect. Its roofs, single and double, brilliantly painted, its gaily diapered porticos, the gloss over the whole surface, the harmony of this species of decoration with the light and flowing forms of the buildings themselves, so please the eye when it is accustomed to see them, that our cold and monotonous mode of decoration may well appear uninviting in contrast.

ARCHITECTURE, *Egyptian.* The preservation of the Egyptian monuments of architecture, in many instances so perfect as they still appear, is highly calculated to excite our surprise and admiration, inasmuch as ancient Egypt ceased to exist in its splendour long before the period of the earliest histories that have come down to us. Almost, as it were, separated from the rest of the world, by seas of sand as well as water, and bordering on the most savage tribes, it seems indebted to those circumstances for the protection its edifices have received. Had the country received as successors to its early inhabitants a powerful people, if rich and industrious cities had risen on the sites of the old ones, the temples of Egypt would doubtless have been used as quarries admirably suited to the purpose. Arabian hordes, and the almost barbarous and wretched inhabitants of the present day, have indeed built their villages on some of the ancient sites. The terraces of some of the temples serve as floors to modern habitations; and at Thebes, a town of two stories, or rather two stories of towns built on the ceilings of these everlasting ruins, indicate that the means of destruction have not been equal to the natural resistance of works of such solidity.

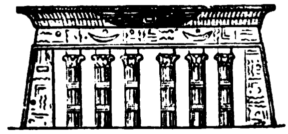
In a preceding article we have adverted to the three classes of mankind whose different wants had an influence on their styles of architecture. It seems to be no forced supposition that the primitive inhabitants of Egypt used the excavations with which nature furnished them for protection against the heat of a sultry climate. It is true that their country is not the only one in which excavations abound; but in most other places these excavations have been caused by working them as quarries, and no trace of architecture or human abode can be perceived in them. In Egypt, on the contrary, where the caverns still furnish dwellings for the inhabitants, immemorial custom has assigned them to the use of mankind. The immense subterraneous apartments of Egypt need not all be placed to the account of luxury in sepulture. Throughout Egyptian architecture its origin appears. A simplicity bordering on monotony, extreme solidity amounting to heaviness, are its principal characteristics. There is an entire absence of everything that can be traced to a type of carpentry, as in the Grecian orders;

hence it appears likely that at least its type was different, and that this type was cavern excavation. The exception that seems to arise from the use of columns does not militate against the theory; for decoration invariably refers to nature for objects of imitation: and nothing would sooner occur in decorating pillars than the imitation of trees and plants, without referring to them as a type. Here, however, the judgment of Mr. Fergusson must be allowed to carry great authority. A thorough acquaintance with the rock-hewn temples of India has led him to refer all such buildings to an original wooden type. Thus, in his opinion, the sloping walls of the Egyptian temples were not originally suggested by still earlier works in rock, but the latter had abandoned, from the force of physical requirements, the perpendicular supports of their wooden model, and the later architects then came to recopy in stone the changes which had been thus introduced. (Fergusson, *Handbook of Architecture.*)

The honours of sepulture seem to have been the cause of the most stupendous of the Egyptian monuments. Diodorus Siculus tells us that the kings of Egypt expended sums upon their tombs more immense than other kings did upon their palaces. Some have supposed that the pyramids were but immense cenotaphs, and that the bodies of the kings were interred in some neighbouring subterranean spot; in short, that these masses of stone were erected to mislead one from the spot which the body occupied. This, however, would not make them the less monuments of sepulture. Some have attributed to the pyramids a mystic, others an astronomical, purpose.

From Egypt were derived the principal mysteries that passed into other religions, and it was in the darkness of subterranean apartments that those initiations had birth in which secrecy was the first law. Secrecy was there deified under the figure of Harpocrates. According to Plutarch, the sphinxes with which the entrances of their temples were decorated signified that Egyptian mythology was mysterious and emblematic. The number of vestibules enclosed with a series of doors prevented the temple itself from being seen. This, which none were allowed to approach, was small in extent, and in it the sacred animal or its image was preserved. It was in the galleries, porticos, and dwellings of the priests, that the large area which the temples covered was occupied.

Excepting some varieties in the plans of their temples, a sameness of character and uniformity is observable in their fronts, their general forms, and the details of their decoration; the latter being mostly of the hieroglyphic species, certainly the most monotonous of all decorations. To give the reader a general idea of the temples of the country, a diagram of that at Esneh is subjoined. With the Egyptians, heaviness seemed to be synonymous with strength, height with grandeur, and size or mass with power. Uniformity of plan is universal. The right line and square was never abandoned, and, as M. de Caylus observes, there exists no circular monument in this style. In the elevations the uniformity is still more striking; there is no division of parts, no contrast, no effect.



Esneh.

As respects the materials for building which the country afforded, we shall speak as concisely as possible. Though palm trees are found about the deserts of Lybia, and near Dendera, timber of every sort is scarce; indeed, the soil is not suitable to the growth of trees. The most common next to the palm tree is the acacia; but, with the exception of the palm tree, most of the trees of Egypt are unfit for building purposes. The oak does not grow in Egypt, and the modern inhabitants import that from Arabia, as well as the fir which they use in their buildings. Brick seems to have been a material used from the earliest date; it was unburnt, being merely dried in the sun. Pocock says it is made of the mud deposited by the Nile, which is of a black colour, sandy, and mixed with flints and shells. One of the pyramids described by Pocock was constructed with this species of brick, and unconnected by any cement. Bricks, however, were used after undergoing the heat of the fire at a very early period, as we learn from Exod. v. 6, where we find the Israelites condemned to the labour of making bricks without straw to burn them. Stone of almost every description, marbles, and granite, were to be had in profusion; and these, as we have before observed, the Egyptians were very expert in working.

In construction there must have been considerable mechanical knowledge employed, for some of the blocks of stone were of enormous dimensions; and to form an idea of the quantity used, it is only necessary to mention that the walls of some of their temples extend to the extraordinary thickness of twenty-four feet. Indeed, the walls to the principal entrance of the gate at Thebes are at their base not less than fifty feet in thickness. The stones are all squared inside as well as on the external face; no rubble-work is to be seen; another cause of the surprising durability of their monuments. The roofs are all formed of single blocks of stone from pier to pier; no trace of the arch is anywhere discoverable. In the pyramids the passages are covered with stones inclined to each other, terminating in a point, one stone lapping over the other.

The Egyptian temple, unlike that of the Greeks, which may be almost all taken in at one view, consists of an assemblage of porticos, courts, vestibules, galleries, and other apartments communicating with one another, each of which in size had little relation to the rest of

the edifice. They were usually in a spot surrounded with walls; and those which were not so surrounded were enclosed in front by a wall engaged to the columns, and extending in height about a half or a third of the shaft. Strabo says that at the entrance of temples was a large paved court three or four times its width in length, which the Greeks called the dromos. This was ornamented with sphinxes in rows. Through the dromos was the propylum or fore portico, which led to another, and that to a third, the number of them not being fixed. Beyond the propyla was situated the temple itself (or naos), which consisted of two parts, the pronaos or fore temple, and the secos or sanctuary, which in Egyptian temples was very small, and contained a figure of the divinity, usually represented under the form of some animal. Some of these temples were of very large dimensions; that of Jupiter at Thebes was more than 1,400 feet long and 300 feet wide, exclusive of the porticos that led to it. The forms of all the plans are either square or rectangular. The art of designing a plan in modern architecture becomes difficult from the necessity of keeping the apartments within such bounds that they may be covered or roofed, and of arranging the decorations, and of counterpoising thrusts; but the Egyptian architect had no such difficulties to contend with. Columns were brought to the spot and covered at once with masses of stone, all combining without much contrivance with the exterior walls: hence, the abundant use of columns in the interior of their buildings. Great regularity appears in their plans. The temple at Philæ, evidently from its being suited to the form of the island on which it was built, is the only exception. Their intercolumniations are narrow, rarely exceeding twice and a half the width of the column, and usually not more than a diameter and a half. The elevation is always uniform and monotonous, always of one story, and without columns above columns. The pyramidal form seems to pervade every edifice, and the result must be great solidity. Their columns may be considered as of two sorts, circular on the plan, and polygonal; the only difference between the former being that some are, and others are not, sculptured with hieroglyphics. Those which represent as it were bundles of rods or trunks, are generally encircled at different heights with bands like the hoops of a cask, generally in two or three ranges of three, four, or five each. This part of the arrangement seems to have been quite arbitrary. The polygonal column frequently occurs, but more generally where the edifice has been formed out of a rock or quarry. All the columns rise from their bases in right lines, diminishing to the top, without any appearance of entasis or swelling. One can hardly say that any precise proportion is preserved between their height and their thickness. In describing them, we can only say that they were short, thick, and of enormous diameter, the latter in some cases extending to as much as eleven feet. What are understood by pilasters are not found in Egyptian buildings, (though some quadrangular columns might give that idea), excepting only in the small sepulchral chamber of the great pyramid. Bases are also rarely found; but the capitals of their columns exhibit great variety. In general form they are either square, vase-formed, or swelled; some of them are very elegantly shaped, and decorated with the lotus, the palm branch, and other kinds of vegetation, and occasionally with the human head. They are usually without abacus, and are connected with the architrave by a small die or square block out of the same piece of stone as the capital. The entablature rarely, if ever, consisted of more than an architrave surmounted by a huge cavetto, which finished upwards with a bead or fillet. This cavetto was frequently ornamented with glyphs and other indentations of the surface, and the wings of the vulture in the centre. The covering of the temple was a flat terrace, though no remains of steps show that they were used.

Some years ago a question was proposed by the French Academy of Inscriptions and Belles-Lettres, whether the Greeks borrowed their architecture from the Egyptians. That question has been well answered by M. Quatremère de Quincy, in the *Encyclop. Méthod.*, to whom we are indebted for much in this article, and the substance of his answer is as follows:—There is no such thing as general human architecture, because the wants of mankind must vary in different countries. Architecture sprang as well from the huts of Greece, as from the subterraneous excavations of Egypt and the tents of Asia, and from several mixed principles to us unknown: thus the use of the word architecture is absurd. We ought to name the species; for between the idea of architecture as a genus and as a species, there is the same difference as between language and tongue: and to seek for a simple origin of architecture is as absurd as a search would be after the primitive language. If so, the hut of Vitruvius would not be an ingenious fable, as some have said, but it would be a ridiculous falsehood if he had pretended that it was the type of all architecture. Vitruvius, however, spoke only of Grecian architecture; and if in Egypt there exists another type, that only proves that the hut was not the type of Egyptian art, but that it was that of Greek art, and that theory would be fabulous which pretended to be universal. Similarity between certain forms of ornament proves nothing more than that between the people by whom they were used there was some interchange of commerce or other intercourse, which could not long subsist without some sort of necessary transfusion of the inventions and habits of one of those countries into the habits, manners, and customs of the other. But in the case of the Greeks even such secondary influences were but slight. When Egypt had been fairly thrown open to Greek commerce, the fashion soon set in of attributing the origin of science, as well as of art, to that mysterious land of which the

priests, in their own interest, knew well how to enhance the wonders. Hence they were not unwilling to believe that the astronomy of Aristarchus, Ptolemy, and Hipparchus, simply systematised a knowledge for which they were indebted to Egyptian observers. The notion is utterly baseless; but the Egyptians eagerly seized on admissions which chimed in with their national vanity. How completely the theory collapses on careful examination, may be seen by a reference to the treatise of Sir G. Cornewall Lewis, on the *Astronomy of the Ancients*, chap. iii. sect. 3. The independent origin and growth of Greek art cannot be called into question with greater reason than that of Greek science.

Architecture, *Gothic*.—For general purposes Gothic architecture may be described as the architecture of Western Christendom. Speaking more strictly, we must regard it as more especially the architecture of the Teutonic races. It was never really naturalised in those countries in which Roman architecture had predominated.

Few forms of art present such an infinite variety of developments; few have given rise to so much controversy, or been made the subject of a greater number of theories. Without discussing such debated points as the introduction of the pointed arch, or the influence of Saracenic architecture on the Gothic, we may yet trace out the essential differences which distinguish it from the styles of architecture which preceded and gave birth to it, and classify the several developments of Gothic, so as to present a clear view of their leading principles. By this process we may avoid entering on long discussions as to the merits of the systems of nomenclature which have been employed by various writers, while we may lay down the broad divisions under which all possible developments of Gothic architecture may without difficulty be arranged.

The genuine architecture of the Romans was that of the round arch, a form which in their hands might have produced the most astonishing results, had they not chosen to abandon it for foreign forms, or to conceal its real character by a system of decoration in no way suited to it. The real architecture of Rome is seen in its aqueducts, bridges, &c.; the adoption of the Greek architecture of the entablature disguised its real nature and repressed its growth. Christian architecture was in its first stages a return to genuine Roman forms, nor can it be said to have inherited from the architecture of the Greeks more than the ornamentation which it received through that of Rome. If Romanesque buildings continued to exhibit in the capitals of their piers forms which approach very closely to Greek types, their general character was the result of principles which exercised on Greek art no influence whatever.

Before the reign of Constantine, Christian architecture can scarcely be said to have had any existence; and when, at his conversion, the empire became nominally Christian, the existing temples were found unsuited to the requirements of the faith which he professed. But the basilica, or secular hall of justice, furnished a type as susceptible of development as it was preeminently adapted for the accommodation of large bodies of worshippers. An oblong area, broken by two rows of columns into three divisions, the central being the widest, furnished a plan which might be amplified to any extent, while the tribunal of the magistrate and his assessors presented the model for the arrangement of the altar with the seats of the bishop and presbyters. In this form we have the genuine precursor of the most complicated Gothic buildings; and the type of the Roman basilica is reproduced uninjured in Westminster and Cologne.

In the construction of these basilicas the architecture of the entablature is seen combined with that of the arch.

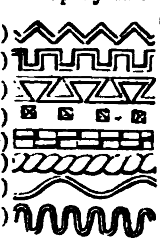
Their columns were frequently the spoils of ruined heathen temples; but the greater difficulty of procuring architraves led to a larger employment of the arch, and this in its turn to the construction of groined vaults. Here the Christian architects had only to revert to the forms presented by earlier Roman buildings. The Temple of Peace at Rome exhibited the profound knowledge of the Romans in the practice of vaulting; nor was this knowledge lost in the decline of Roman architecture down to the days of Diocletian. In the baths of this emperor are to be seen not only groined vaults in three divisions, whose span is nearly seventy feet, but at the back of each springer a buttress, precisely of the nature of a flying buttress, is contrived to counteract the thrusts of the vaulting. If a comparison be made between this large hall (now used as a church) of the baths of Diocletian with the nave of a Gothic church, the contrast will be found to be more such as must result from the nature and employment of the materials, than from difference of style.

The architecture thus developed, which we may designate by the general term Romanesque, was necessarily a transitional one. The employment of the round arch introduced into buildings the principle of verticality; and although for ages the architects continued scarcely conscious of it, it was constantly changing the character of their designs. The several varieties of this style in different countries exhibit the influence of local traditions and national genius; but through all the many phases of Byzantine, Lom-

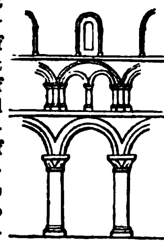
bardic, and Rhenish Romanesque, the Anglo-Saxon, and the Norman of France and England, the prominent characteristics of this style are solidity and rest. Yet, with this similarity, the forms developed in the East and West were very different. In the former, every other object was made subservient to the cupola. For the complete development of this design, the nave of the Latin cross was too long, the choir and transepts too short: hence the four limbs are made equal radii of a single circle, and are surmounted generally each with its own dome, which clusters round the great cupola which soars above them.

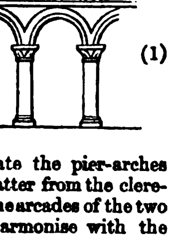
In England the period of Romanesque architecture extends to the close of the eleventh century, and may be subdivided into the Anglo-Saxon and the Norman. Of the former there are but few examples remaining; and some of the buildings which were begun before the Conquest show the influence of Norman on English art during the reign of Edward the Confessor. As compared with the Norman which succeeded, the style is characterised chiefly by its simplicity or poverty. The arches are always semicircular, the columns single and so low in proportion to their height as to be not more than three and a half diameters high. The windows are little more than slits a few inches in width, and splayed or levelled off on the inside through the whole thickness of the wall. The walls, which are very thick, have no external buttresses. The ceilings were open-timbered, a few vaults being found in crypts. The plan usually presents a nave (sometimes with aisles) separated by an ornamented arch from the chancel; but the elevations seldom show more than one tier of arches with a range of windows above.

The examples of Norman architecture are very abundant, in cathedral and conventual as well as in parochial churches, some of the most splendid specimens being found at Ely, Peterborough, Norwich, Durham, Wimborn, Romsey, &c. In its earlier stages it differs from Anglo-Saxon chiefly in size and the quality of the work. The round arch is still universal; the window is but slightly enlarged, and remains a mere aperture. But the buildings gained rapidly in height, and exhibit a much greater variety of ornamentation. Among the ornaments employed were the chevron or zigzag moulding (1); the embattled frette (2); the triangular frette (3); the nail head (4); the billet (5); the cable (6); the wavy (7); the nebular (8); and some others. Many of these were used in the preceding period, as well as many which have received no names.


(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)

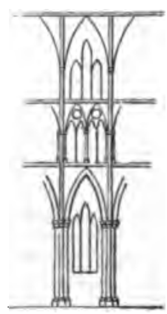
But the great change, displayed in the Norman, is to be found in the elevation of the interior, exhibiting the triple range of (1) pier-arch, (2) triforium, and (3) clerestory. Here at once we have a style which bears no resemblance to the Greek; but this opposition is only the mechanical result of employing a different constructive form. If the arch had introduced the principle of verticality, it showed itself as yet only in the increased height of the building. There is no subordination or connection of the parts. The string-courses which separate the pier-arches from the triforium, and the latter from the clerestory, are unbroken; while the arcades of the two latter frequently do not harmonise with the range of the pier-arches. Where the design is strictly of this kind, the building cannot be said to have any Gothic character. It is purely Romanesque. There is no such connection between the parts as that the abstraction of one feature should at once destroy the whole design. They are, indeed, no otherwise connected than as being included under one roof. But the true mark of Gothic is the union of its component parts; and the first approach to such a connection indicates a period of transition. As soon as shafts running up from the piers divided the triforium and clerestory into compartments, the genuine Romanesque character of the building was gone, and the principle of Gothic architecture had taken its place. To this transitional period belong a vast number of Romanesque or Norman buildings in England and on the continent; while in many the departure from the Romanesque type is so great as to remove them almost from the class of Romanesque to that of Gothic designs. To whatever height a building may be raised, it is clear that its full effect cannot be attained as long as uncut horizontal lines divide the whole structure into separate layers. But although the parts may be subordinated while the round arch is retained, this subordination led naturally to the more frequent use of the pointed arch; and a radical change ensued on the general adoption of a form which, in its occasional employment, had given no indication of its general powers. This feature forced on the mind the idea of relation, and that which is strictly Gothic architecture at once came into existence.


(3)
(2)
(1)

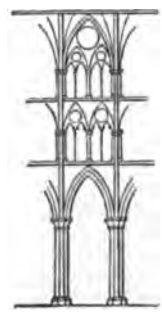


Thus the fundamental characteristic of Gothic is unity. But it is obvious that unity may be attained in more ways than one; it may be secured by the fusion of the parts, as well as by their subordination. Their existence may be absorbed and lost, instead of going each in its degree to make up the whole. These two methods of obtaining architectural

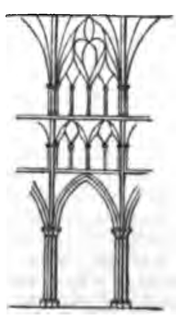
unity embrace every phase of Gothic architecture, and admit of the systematic classification of all transitional examples. The turning-point has then been reached when the first symptom is seen of a tendency to fuse one form into another. It is clear that, examined by this test, the styles known as the Early English, or Lancet, or First Pointed, and the Geometrical Decorated, or Second Pointed, belong to the first division; while the Flowing Decorated and the Perpendicular or Continuous styles belong to the second. Hence it follows that the one designation of Decorated or Second Pointed, for both the Geometrical and Flowing styles, involves a false classification. There is an entire difference of principle between the two. So long as the forms employed were only geometrical, the later styles could not possibly have been developed: the introduction of flowing or continuous forms (whatever may be their beauty) insured the decline of Gothic architecture. This will be seen by a reference to the accompanying woodcuts.



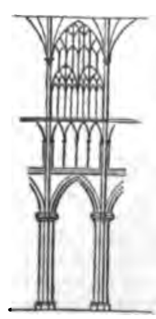
Early English or Lancet.



Geometrical Decorated.



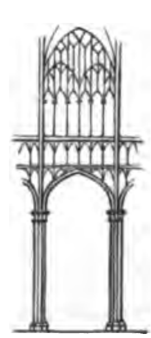
Flowing or Late Decorated.



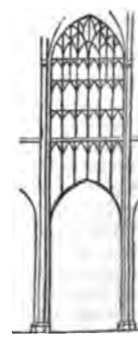
Continuous or Perpendicular.

By a comparison of the Flowing Decorated with the Geometrical, we see that the new principle is exhibited first of all in the windows, by the employment of the ogive in place of circular forms—geometrical tracery being, in strictness, confined to the use of circular figures only. (See Freeman's *History of Window Tracery.*) But the ogive forms once introduced soon converted the whole tracery of windows into a series of soft wavy lines, dying into the window arch, and utterly destroyed that subordination of mouldings which was the distinguishing characteristic of the preceding styles. While in the latter the primary mouldings are confined generally to the two principal arches and the circle which they carry, in the former the whole working of a window is on one plane. (See Sharpe's *Rise and Progress of Decorated Window Tracery in England.*)

But inasmuch as the mullions of a window may be extended upwards as well by straight as by wavy lines, it follows that the Flamboyant of France, not less than the Flowing Decorated of England, is in principle identical with the Perpendicular or Continuous style. The question of beauty is, manifestly, entirely distinct from the principle involved in a style. Every change from one principle to another must in architecture be accompanied by a period of transition; and it would seem that to such periods we are indebted for the most beautiful and magnificent designs. On the introduction of the ogive form the declension of

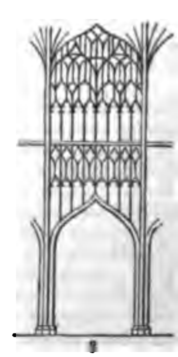


1



2

Gothic architecture became very rapid. 'Even the most important features were at length merged in the production of a collective unity. The capitals of the piers became more wiry and



3

slender (1), and at last were removed altogether (2). String-courses and bands became fewer in number. The pier-arches assumed the

ogeed termination (3), from which, as from the apex of every opening of the triforium, straight lines ascended without interruption till they were lost in the interlacing tracery of the vaulting. Thus, that very form of architecture—the truest, the most beautiful, the most magnificent, that the world has yet seen—the genuine offspring of the pointed arch, whose highest triumph was the achievement of a glorious unity of separate existent parts—gave birth, by a strictly logical process, to a wholly antagonistic idea, which necessitated the abandonment of the very feature which had been its essential and most splendid characteristic; and, by a growth of marvellous rapidity, the principle of the subordination of parts ended in their ultimate absorption.' (*Edinburgh Review*, No. 213, p. 134.)

In Germany, the Gothic architecture followed a course similar to that of English Gothic, with one remarkable exception. It has nothing answering to the style known as Early English (or Lancet, or First Pointed). The pointed arch and lancet window, adopted first in France, had effected a complete change in English buildings, while the old forms continued to exercise all their influence in Germany. There is nothing in England of that unswerving retention of primitive character which marks the Rhenish Romanesque. It is not surprising, therefore, that, when these forms were once abandoned, German architecture should make a sudden advance, comprising in one stage the interval extending from the Norman to the Geometrical Gothic of England.

Of the many theories, some plausible, others more or less absurd, which have been advanced to account for what is called the invention of the pointed arch, it is scarcely necessary to say more than that the simplest and therefore the most attractive (that, namely, which traces it to the requirements of vaulting) is as untenable as the rest. Professor Willis, in his *Remarks on the Architecture of the Middle Ages*, has shown that so far was this form necessary for the vaulting of rectangles of different lengths and breadths, that several methods for accomplishing this had been employed for a long time, and continued in vogue long after the change from round to pointed forms.

The great criterion of the differences between each style of Gothic architecture, whether in principle or in detail, is to be sought (as has been already noticed) in the tracery of their windows. Here the subordination of parts is most clearly brought out in the earlier stages of the Geometrical Decorated; while the substitution of the vesica for the circle and triangle first betrays the introduction of a different principle from that which had brought about the change from Romanesque into Gothic.

As compared with the cathedrals of France and Germany, the great ecclesiastical buildings of England exhibit great differences of plan and design. In England, after the Romanesque period, the square end was substituted in churches for the apse. In France the retention of the more strict basilican form led to a great development of the idea of verticality. The cathedrals of Amiens and Cologne are not so long internally as those of Canterbury, Winchester, and York; but they exceed the latter in height by fifty or sixty feet. This great internal height involved also the retention of double aisles, of which the outer round the apse is formed into a series of chapels themselves apsidal; but it also involved the modification or abandonment of the external features which are the great characteristics of English churches. It was impossible to raise such central towers as those of Canterbury and Lincoln in buildings whose height varies from 120 to 160 feet; and even the western towers cease to bear the prominent character which they exhibit in English designs. The great end of the continental architects was height; the English architects, with a more marked external outline, compensated for comparative want of height by the greater length which furnishes an almost boundless perspective in such buildings as the abbey church of St. Alban's and the cathedrals of Winchester and Ely. The development of Gothic architecture in England and on the continent was in principle the same; but it exhibited in each case a distinctive national character which it is impossible to mistake.

Periods of English Architecture.—In attempting to assign dates for the duration of successive styles in architecture, it must be remembered that each stage is preceded and followed by a period of transition, and that hence a building which chronologically belongs to a Romanesque period may to an indefinite extent exhibit a Gothic character, while in others the characteristics of a former style may be retained when that style has passed almost wholly out of use. This intermingling of styles is especially discernible in the later stages of Gothic, and most of all in the periods which are commonly classified under the name of the Decorated style. This style has philosophically no existence, and really consists of two stages, one of which adheres to the true Gothic principle, while the other has virtually abandoned it. The names to be assigned to these two stages remain still a subject of controversy; but it is comparatively a matter of indifference whether with Mr. Petit we speak of Early Complete and Late Complete Gothic, or if with Mr. Sharpe we call them respectively Geometrical and Curvilinear, so long as we remember that the principle of the Late Complete Gothic, or the Curvilinear, is identical with that of the Rectilinear (or Continuous or Perpendicular) style.

Thus the lines of demarcation between one style and another are not so sharply drawn as is commonly supposed; and there are subdivisions of styles even where we speak generally of only one. In the architecture of this country three stages may be traced before the prevalence of that form of Romanesque which is especially associated with the Norman

conquerors of England. The first stage is little more than a debased form of Roman work; to this time belongs Brixworth church, which was probably built in the latter part of the seventh century. Of the second period the church at Earl's Barton is perhaps the best specimen. During this time the use of masonry was extended to the smaller churches, which had previously been built of wood, while the distinguishing peculiarities of Saxon work were still retained in all. (See Freeman's *History of Architecture*, p. 217.) In the following period, the use of wood was generally discarded for that of stone, and the buildings exhibited less and less of the peculiarities of timber construction. The straight-sided arch became more rare, and the shaft was substituted for the baluster. To this period belongs part of the church of St. Peter-le-Gowts, and of the cathedral of Oxford, prior to the changes which it underwent at the end of the twelfth century.

If the Norman conquest was speedily followed by the prevalence in England of that form of Romanesque which had already raised some splendid monuments in Normandy, the introduction of this style was not entirely owing to the defeat of Harold at Hastings. Norman architects had already been employed by Edward the Confessor, and the church which Harold built for the secular canons of Waltham so far exhibited the characteristics of Norman Romanesque as to make the date of its erection a matter of doubt and controversy in the present day. But we are told in plain terms that Edward built his abbey at Westminster in a new style, and the work of Harold at Waltham is only a further proof of the extent to which the Norman Romanesque was influencing the architecture of this country. No style has left behind it more enduring memorials. During the period of its prevalence, all the cathedral and most of the conventual churches in England were rebuilt, while innumerable new buildings were raised throughout the country. It is scarcely necessary to adduce instances, but the cathedrals of Ely, Peterborough, Norwich, Chichester, and Durham, may be mentioned amongst the most magnificent examples.

But although the Norman Romanesque must be regarded as a substantial and not merely as a transitional style, it must be remembered that in proportion as it combined all the parts of a building into one harmonious whole, it tended to introduce the principle of Gothic architecture, and this tendency became manifest during the reign of Stephen, A.D. 1135–1154. The round arch was now more and more superseded by the pointed arch, and clustered shafts took the place of columns. From the character of the windows, which exhibited merely the grouping of apertures, without any approach to genuine tracery, this period has been known as the time of the Lancet style (or the First Pointed in the nomenclature of the Ecclesiological Society). Among the more remarkable examples of the Lancet or Early English style, may be mentioned the abbeys of Whitby and Beverley, the presbytery of Ely Cathedral, the cathedral of Salisbury, the transepts and choir of Worcester, &c.

The commencement of the next period, which marks the prevalence of the Geometrical or Early Decorated style, must be dated from the introduction of tracery, which at the first was confined to purely geometrical forms. This period (allowing for the time of transition) extends down to the reign of Edward II.; and among the most important examples may be mentioned portions of Westminster Abbey, in its earlier stage; Merton Chapel, Oxford; Exeter Cathedral, Lichfield Cathedral, the spires of Salisbury and Norwich.

The abandonment of pure geometrical forms marks the declension of real Gothic architecture; but the employment of curvilinear forms was introduced long before any marked change in the character of English architecture became perceptible. Although, however, there could be, in strictness, no intermediate form between geometrical and flowing tracery (Paley's *Architecture*, p. 173), yet the two styles might be combined, not only in the same building, but even in the same window. Hence it becomes extremely difficult to classify the buildings belonging to this period of transition. As specimens of such intermixture may be mentioned the eastern windows of Carlisle and Bristol cathedrals, and the western window of Exeter. But this period was rapidly succeeded by what is commonly known as the Perpendicular, in which the tracery was carried to the head of the window in straight lines instead of flowing lines. The full development of this style may be assigned to the reign of Edward III.; and to it belong the naves of Winchester and Canterbury, the encasing of the choir of Gloucester, the church of St. Mary Redcliffe, Bristol, &c. Of the history of this style we have already spoken; and we need therefore only specify among its later examples the chapels of King's College, Cambridge; St. George's, Windsor; and the still more sumptuous chapel of Henry VII. at Westminster.

One of the most striking features which distinguish English from continental architecture is the employment of wood for the roofs whether of halls or churches. To the former they were applied from the reign of Edward III. About A.D. 1400 they were employed in churches, wherein prior to that date stone vaulting appears to have been more common. The Norman castles had their keeps and halls vaulted with stone, as was the case with those in North Wales built by Edward I.

Our limits preclude us from adverting to many fine specimens of ecclesiastical architecture in Scotland; but the abbeys of Melrose and Kelso, founded by David I., as well as those in Dryburgh and Jedburgh, all in Roxburghshire, show that the art was carried to as great perfection north of the Tweed as in the southern parts. Roslin and Holyrood Chapels, for richness and variety of ornamental carvings

'rst erected by Sir William St. Clair), be exceeded. Its plan is without pa- any other specimen of the fifteenth The latter was finished by James, .. of that name, in 1440; and is a ..al specimen, with flying buttresses, ..ore ornamented than any even in England.

It would be impossible here to enumerate the palaces and private Gothic buildings of this country, of which parts still exist in the remains of the ancient palace at Westminster, Eltham, Kenilworth Castle, Hampton Court, and in many other places. The following list exhibits the dimensions of the different cathedrals in England.

Total Internal Length in Feet		Internal Breadth of Transept	Choir		
			L.	B.	H.
Old St. Paul's	500	248	165	42	88
Winchester	545	186	138	—	78
Ely	517	178	101	73	70
Canterbury	514	154	150	74	80
York	498	222	131	—	99
Lincoln	498	227	—	—	—
Westminster	489	189	152	—	101
Peterborough	480	203	138	—	78
Salisbury	452	210	140	—	84
Durham	420	176	117	33	71
Gloucester	420	144	140	—	86
Chichester	401	131	100	—	—
Norwich	411	191	165	—	—
Lichfield	411	88	110	—	67
Worcester	410	130	126	—	74
Exeter	390	140	131	—	69
Wells	371	135	106	—	67
Hereford (ancient)	370	140	105	—	64
Chester	348	—	—	—	—
Rochester	306	122	156	—	—
Carlisle	213	—	137	71	—
Bath	210	126	—	—	—
Bristol	175	128	100	—	—
Oxford	154	102	80	—	37½

ARCHITECTURE, *Grecian*.—Grecian architecture, which was transplanted after its perfection to an Italian soil, where it assumed almost another form, will not require an extended notice in this place. The particular detail of the changes it underwent will be found in the articles DORIC, IONIC, and CORINTHIAN orders. Its origin and types have already been considered in the article Architecture, and an explanation of its terms will be found under their several heads in this work.

The value of the legends which ascribe to Cadmus the introduction of the worship of Egyptian deities, with the practice of quarrying stone, has been already examined in the article on Egyptian architecture. The Greeks at an early period had raised some extraordinary structures, such as the treasury of Minyas, king of Orchomenus, and the walls of Tiryns, which still attest the truthfulness of the Homeric poet and of Pausanias. From the Homeric writings we find that the form of government was patriarchal, that the chief buildings were the palaces of the princes, and that the altar was the only structure for sacred use, and that even this was little more than a hearth, on which the victim was prepared for the meal; for, until after Homer's time, no regular priesthood existed in Greece. It seems probable that the temple was not used until the kingly and sacerdotal offices were separated. It would be difficult, perhaps now impossible, to trace the degrees from the use of the simple altar to the establishment of the regular temple, or when the latter became a necessary appendage to the religion of the country. The houses of the Greeks appear to have been simple in plan, and at an early age consisted of two stories, as was indeed the case with the dwellings of the East mentioned in the Scriptures.

Goguet (*Origine des Lois*) says that Asia Minor was the cradle in which architecture was nursed, and thinks that to this country we are indebted for the invention of the Doric and Ionic orders. All authors seem to admit that the Corinthian had its birth in the mother-country, and not in the colonies. Perhaps the earliest temple recorded is that of Zeus or Jupiter at Olympia, which, according to Pausanias, must have been built 630 years before the Christian era. If Livy be right, that of Artemis at Ephesus was of a period little less remote, and at this time the science of mechanics was in its infancy; for even in the time of Thucydides, though the powers of the crane were known, they were not commonly applied for the purpose of raising weights.

Admitting that the system of imitation in the Doric order was founded on the elementary forms and parts of the hut, it was in that case guided by the principles that nature herself adopts in her operations; otherwise no bounds would have limited the caprice and imagination of its improvers. In the copy, no part is precisely similar to the model; but an analogy, and that very strong, is observable. The proportions and parts of the Doric order, in different examples, plainly indicate that the Grecian artists considered themselves restricted only by general rules, inasmuch as we find them varying the height of the Doric column from four diameters to six and a half [DORIC ORDER], while the height of the entablature varies in terms of the diameter from 1·72 to 1·97. The intercolumniations used in the Doric order at Pæstum, Corinth, and Segesta, and in the Parthenon, are equal to about one diameter of the column. They are about a quarter of a diameter more at the Temple of Theseus, whilst in an example at Syracuse they are somewhat less than a diameter.

The age of Pericles exhibited almost all that art could be imagined to accomplish; the Peloponnesians and their colonies had erected the temples at Corinth, Nemea, Pæstum, Syracuse, and other places in Sicily; thus, in a space of little more than three hundred years from its introduction, it appears that the art was raised to the summit of perfection. It is probable that the Ionic order is not far behind the Doric in antiquity. In the former, the different examples exhibit a variety not less to be noticed than that which we have observed in the latter order. The height of

the Ionic column varies in the three examples of the temples on the Ilissus, of Athena Polias, and Erechtheus, from eight diameters and a quarter to nine and a half; but in the heights of the entablatures there is not so much variation. The cornice of the Grecian Ionic may be considered as bearing a constant ratio to the whole height of the entablature, as 2 to 9; while the whole height of the latter seems nearly constant at two diameters in height. This order received the addition of a base to its shaft, which was wanting in the Doric order; but for the varieties the reader will refer to that article in this work. The volutes, which are its distinguishing features, are found with many varieties. In the temple on the Ilissus, in that of Athena Polias at Priene, and that of Apollo Didymæus, the volute contains only one channel between the revolutions of the spiral; whereas in those of Erechtheus and Athena Polias at Athens, each volute has two distinct spirals with channels between them. In the former of these two the column terminates with an astragal and fillet, just below the eye of the volute; in that of Athena Polias with a single fillet. In each, the neck of the capital is ornamented with honeysuckles. The shafts are usually cut with flutes of an elliptical form, to the number of twenty-four. These flutes vary from those of the Doric order, in their separation from each other, through the intervention of fillets.

The distinguishing feature of the Corinthian as of the Ionic order is the capital. But our knowledge of the Greek Corinthian order is unfortunately circumscribed, from the destruction and decay to which from its extreme delicacy it was exposed; nevertheless, under even these circumstances, the few examples that remain induce a supposition that it was not in such high estimation as those we have already named, inasmuch as the only examples that have come down to us are found in what is called the Tower of the Winds, and the Choragic Monument of Lysicrates, both at Athens. But the former of these is scarcely to be classed among examples of Corinthian, and the latter (as we now understand the Corinthian order) is in some respects a little eccentric in character. In the Choragic Monument the height of the entablature is somewhat less than a fifth of the total height of the order. The base varies little from that of the Ionic order, excepting in the non-appearance of the horizontal fluting in the upper torus.

To the orders enumerated may be added one scarcely to be named here, because apparently under no rules which regulated its proportions, namely, the figures called Caryatides, which were employed for the support of an entablature. For the supposed account of their origin, the reader is referred to the article Caryatides.

The only subject remaining for notice, under this head, is that of the roofs of the Grecian temples. They consisted, of course, of two inclined sides, which at the ends formed a pediment. From experience it was soon found that the angle at which the sides of a roof should be inclined to the horizon should be such as effectually to shelter the interior of the building from the inclemencies of the seasons. Hence greatly inclined roofs are indispensable in northern climates; the reverse as the climate approaches the equator: but this will be more fully explained under the article Roof. Here we shall merely state that, according to the hypothesis, the inclination of the sides of a roof should, for the latitude of Athens, be 16½ degrees. The actual inclination of the roof of the temple of Erechtheus is 15½ degrees, temple of Theseus 15 degrees, the Parthenon 16 degrees, and that of the Propylæa 14½. Comparing the law with the Roman examples, the climate would require an inclination of the sides of the roof with the horizon of 22 degrees, and the variation between the examples remaining is from 22 to 24 degrees.

The invention of the arch does not at present appear to belong to Greek architecture.

Architecture, *Indian*.—It is very properly observed by M. Quatremère de Quincy, that, in spite of all theories, an infallible mode of estimating the state of the architecture and other arts of any people is by their representations of the human form. Every people, he says, who during a number of ages have persevered in falsely representing the figure void of all proportion, and according to a certain barbarous and ignorant routine, must be convicted of a want of that sentiment which leads to a knowledge of truth, and of that intelligence which knows how to find in nature rules for the choice of forms and arrangements applicable to the art of building. Every people which does not manifest in its works this conformity to nature must be ignorant of the arts of imitation, and all their productions must be the result of an irregular taste. These remarks particularly apply to Indian architecture, whose exact antiquity is still a problematical question. In a country abounding with deserted monuments, where are found the traces of an ancient language now no longer spoken, books no longer understood, and a mythology which bears the closest resemblance to that of Greece, we are naturally led to surmise that civilisation existed at a very early period. These opinions would seem to be corroborated by the extraordinary chronologies which the modern Indians have produced as incontestable authorities for their remote antiquity. The chronology, however, of the Hindoos will not bear the test of strict investigation: neither has any inscription or historic monument been discovered, nor any annals found which give us an idea of the changes, revolutions, or prosperity which the country may have experienced.

It is natural to suppose, that the subterraneous or excavated monuments of India are prior in date to raised or constructed works; and yet, in point of fact, we find in the former neither less minuteness of details, less caprice in form, nor less profusion of fantastic ornament, than in

the latter. Hence the monuments themselves afford us no clue to their respective antiquity. The fact, however, seems to be established, that during a long period the settlers in the great Indian peninsula left few or no architectural monuments, and that this continued to be the case until a change had come over their religion. This fact Mr. Fergusson ascribes to the nature of their belief, 'when every man stood forth in the presence of his God and without intercessors offered up his prayers with the prescribed forms, . . . always feeling himself in the immediate presence of the Deity, and appealing directly to his mercy. . . . . Among such a people it would of course be vain to look for any monuments of importance.' (*Handbook of Architecture.*) But whether the lack of buildings is to be ascribed to the purity of their faith, or, as Gibbon asserted in the case of the Germans, to a want of ingenuity, it may be fairly inferred that the change to Buddhism brought about an increased activity in art as in government.

Construction is a term scarcely applicable to the greater number of works of Indian architecture. It means the raising of a building composed of divers materials, or of pieces joined together to form a mass; hence it cannot be properly applied to an excavated structure. The edifices of India may be divided into two classes, the quarried and constructed; the last are mostly those towers improperly called pagodas. To the unconstructed class belong the seven large pagodas of Mavalipuram, which consist of large masses of stone more or less engaged to the earth, and contiguous to similar masses. These masses were shaped and sculptured externally in accordance with their general form, partly pyramidally and partly by irregular zones, in the same style as the pyramidal tower of the constructed pagoda. No order is apparent in the respective dispositions of the masses, neither is regularity in the plan and exterior form to be detected. These edifices are extremely small in the interior, being hollowed out of the mass, and remind us of the monolithic temples of Egypt, cut out of immense blocks of granite, which, as Herodotus tells us, were removed to very considerable distances. In other respects, there was clearly some resemblance between the art of India and Egypt; it is found in the excavations of monuments, and in working large natural masses of stone in their original situation. But we are scarcely justified in inferring from this similarity of taste that there was communication between the two nations; and still less are we at liberty to infer a resemblance of style in architecture from a similarity of practice; for nothing is more unlike the Egyptian than the Indian style of architecture; and in the end it will be seen that, except in the practice of excavation, there is no similarity at all. The dimensions of the pagodas, as they have been called, compared with those of the Egyptian pyramids, not less than their excavated temples, have been much overrated by travellers. Of the latter, the dimensions are generally moderate, and the difficulty of their execution could not have been very considerable. If the description that comes to us be correct, the latter are hollowed out from quarries of calcareous stone, and the dimensions are on so small a scale, that even the celebrated temple at Elephanta is only 130 feet long, 110 feet wide, and but 14 feet 6 inches high. The operation of hollowing out a cavern of this sort can scarcely be dignified with the name of art; but in the pagoda construction we must admit some display of that which at least approaches it. The pagodas are, in many instances, of considerable height; but to compare them with the pyramids of Egypt is out of the question. These, the only buildings of much height, are pyramidal in general form. Sonnerat (vol. i. p. 217) gives us some idea of them: he says, 'Around the most celebrated temples the surrounding walls are thick and much raised. On each side is a gate surmounted by a pyramidal tower, with a curved mass of enormous size. The tower is loaded with figures,' &c. &c. If we may trust the representation of the pagoda of Chillambaram by M. Durocher de la Perigne, given by Caylus in the 31st vol. of the *Mémoires de l'Académie*, the pyramidal form is therein strongly marked. In it the height of the whole is but 120 feet, and at its base it is but 80 feet wide. The termination is not in a point, but is truncated at a height which makes the plan of its summit about 36 feet wide. The pyramid is of unequal sides, the flanks being much narrower than the faces. But the largest of these monuments is that described by Lord Valentia, namely, the pagoda of Tanjore, which he considers the finest specimen of this species of building. This is 200 feet high, placed on a basement of 40 feet in height. The pyramidal mass rises by twelve sets-off, or bands, sculptured in various ways. Such samples of masonry, however, required no great display of constructive skill for their execution, either in working or transport of the materials. At Chillambaram, for instance, the pyramidal part is constructed to the height of 30 feet only in masonry, the remainder being of brick. The mass is coated with ornaments of stone and of a species of white cement of the country. As in Egypt, none of the monuments of this country exhibit any trace of the arch: the coverings of the apartments are all horizontal, and the dimensions in all are necessarily limited by the want of that expedient which, in modern architecture, has been the parent of the most stupendous monuments of which art was capable. The ceilings in Indian architecture are of enormous blocks of stone, laid on the supports on which the buildings are constructed, being the simplest and most inartificial mode of contriving a covering to an apartment. It must be apparent to every one, that the art of India was many degrees below that of Egypt. Though, in the last-named country, art was limited by the

habits of the people, yet it is equally certain that their knowledge in the use of materials was of a high character, and that their skill in masonry was carried to great perfection.

That which is known to the architect by the term ordonnance, which means, in its most extended sense, the composition of a building and the due arrangement of its several parts, and which the Greeks and Romans practised in their architecture with so much success, is not perceptible in Indian architecture, as far as we are acquainted with it. It seems easy to account for this: for, although some of the existing monuments have received the name of palaces, there is little doubt of their being all destined originally for religious purposes. Hence the architects, confined to certain established routines, were not at liberty to exercise their invention and ingenuity; and even had they been so, the system of castes, in perpetuating uniformity of practice, had a tendency to repress them. Again: scarcely any system could be conceived less likely to develope talent in ordonnance than the use of subterranean edifices, which admit of no variety of plan, no extent of elevation, and do not lead to any of those conceptions which the taste of the architect generates when he has length, breadth, and materials at his command. In the caves at Ellora some of the columns are hexagonal, without base, capital, or ornament; some square, with a long cap, like carpentry. The greater number are composed of three parts: a square pedestal, running up more than one half of the total height; a small portion of shaft, if we may so term it, crowned with a capital of strange form, of which words cannot give any definite idea. The reader may advantageously refer to Daniel's plates of these curious objects. Decoration, in architecture, consists of large and small details, which receive the name of ornaments. The larger parts are columns and similar masses. In the system of Indian decoration there is no trace of what may be called an order; but among the larger masses of decorations for support, sculptured elephants very frequently occur. In one of the temples at Ellora, for instance, there are three masses of building, on the same line, whose bases are sculptured with elephants, seen in face. Lions are also much used as objects for decoration.

These excavations date, as Mr. Fergusson has proved, from a period as early as 200 B.C.; and thus the resemblance which they present to the plan of Christian churches of the basilican type must be set down to similarity of needs producing similar architectural developments, and not, as has been somewhat unreasonably supposed, to a diabolical mimicry of Christianity on the part of the Buddhists. It was impossible that Christian buildings should be copied before they existed.

The primary idea of a Buddhist temple was that of a *tope* or pillar, which, when a monolith, is called a *lât*. These tumuli are generally without ornament, but they vary in form, being sometimes domical and sometimes shaped like a cylinder with the roof almost flat. On the apex was the *tee*, or receptacle for the relic, of which we have already spoken when treating of the architecture of the Chinese. The umbrella which crowned the *tee* was the symbol of royalty. But while the architecture of these topes is altogether external, that of the temples or *chaityas* is wholly internal, no built example of these having been found. These temples Mr. Fergusson attributes, on very strong grounds, to a wooden origin, with the one remarkable exception that the pillars appear always to have been constructed of stone. This he explains from the necessity of guarding against the white ants, by 'placing some indestructible barriers between them and those parts which must necessarily be constructed of wood.'

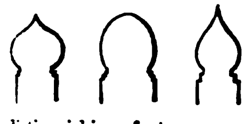
The external treatment of the *viharas* or monasteries is supplied by remains found in Ceylon. Round the raised platform of the Thuparamya tope are three rows of monolith pillars, which once supported a wooden platform, on which were raised in successive stories the cells of the priests. The truth of this supposition is confirmed by the Burmese monasteries or *kioums*, which are also raised on pillars, and which, as being made wholly of wood, explain also the absence of architectural remains in India previous to the introduction of Buddhism. 'Further proof that all more ancient buildings were constructed of wood, is found in the essentially wooden forms of the earlier cave temples, in the same character as discernible in the architecture of Persepolis, as well as in the accounts given of the temple of Solomon—facts which, if Egyptian art also sprang from a wooden type, would go far towards establishing the general prevalence of a primitive wooden construction.' (*Edinburgh Review*, January 1857, p. 120.)

The transition from the Buddhist to the Jaina creed, and again to that of Brahma, produced no new style of architecture. The Hindu temples adhered to the pyramidal form suggested by the Buddhist monasteries, terminating with the umbrella-shaped finial of the early Buddhist topes. The form of their gateways is invariably that of the oblong pointed roof, found in the transition example at Mahavellipore. The most remarkable features of these buildings are their large pillared halls, or *choultries*, which sometimes have as many as a thousand columns. The temples of Northern India consist generally of a great tower or *vimana*, the sides of which are curvilinear; in the centre is the cell for the divinity, and at the summit the umbrella-shaped covering. In front is attached a square *mantopa* or porch, with a door on each face, but without any other opening.

ARCHITECTURE, *Moorish or Saracenic*.—When the victories of the Arabians had extended their empire from Constantinople to the confines of Spain, the magnanimity of their leaders, and the brilliant talents of their caliphs, raised the nation to a pitch of glory and power which exhibited itself in some very extraordinary productions in the architectural art. In Africa

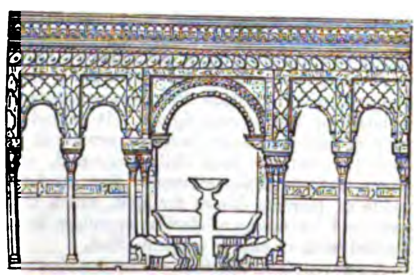
and in Spain, where their empire became firmly established, the edifices they erected sufficiently prove with what success they cultivated the arts and sciences.

We do not, in the narrow limits of such an article as this, think it necessary to extend any inquiry into the earliest works of the Saracens, such as the original Mosque of Omar, built in 640. Neither of that nor of other of their works (few indeed in number) have we sufficient historical evidence to compare them with the architecture of the period in other countries; but we proceed at once to that period when some of its most distinguishing features were such arches as are here exhibited.



The Mosque at Cordova was begun by Abdalrahman, the second king of Cordova, and finished by his son towards the end of the eighth century. Its plan is a parallelogram of 600 feet by 400, formed by an embattled wall with counterforts also embattled; the height of this wall varies from 35 to 60 feet, and its thickness is 8 feet. This large quadrangular space is divided internally into two parts; viz. a court, 200 feet long by the length of the edifice, and the mosque itself, which is about 400 feet square. The mosque consists of 19 aisles, formed by 17 rows of columns, from south to north, and 32 narrower aisles, from east to west. Each of these aisles is 16 feet wide, from north to south, by 400 feet long; the width of them in the opposite direction is less. Thus the intersection of the aisles with each other produces 850 columns, which, added to the 52 columns of the court, form a total of near a thousand columns. Their diameter is about a foot and a half, and their mean height about 15 feet, and they are crowned by capitals of a Corinthian or composite species. These columns, which have neither socle nor base, are surmounted by arches from column to column. The ceilings are of wood painted, each range forming on the outside a small roof, separated from those adjoining by a gutter. One of the most striking effects of the edifice is produced by the beautiful marbles of which the columns are composed. It seems probable that the larger portion of these columns were procured from the Roman ruins in the city; an opinion which is strengthened by their being without bases, or with such as are ill suited to the style of the columns or capitals. In the commencement of the sixteenth century great changes were made in this mosque, for the purpose of converting it into a Christian church; these, it is said, ruined the original effect, but enough is left to indicate what it anciently must have been. It is always considered as one of the earliest Moorish buildings in Spain. The decorations throughout are in stucco, painted of different colours, and occasionally gilt, in imitation of Byzantine churches. One cannot doubt that its architects were well acquainted with the Byzantine architecture, in which the walls, the arcades, the pavements, in short all the parts, were covered with paintings; and it is clear that the Arabians, who really had invented no architecture of their own, spreading themselves in those countries wherein the arts had been established, were thus led to a trial of imitating the old masters.

The Alhambra, at Granada, is perhaps the most curious and interesting Moorish edifice in Spain. It served the double purpose of palace and fortress, and is situated on the summit of a rock that commands the town. According to travellers who have described this edifice, the visitor may here fancy himself in a fairy-built dwelling. After passing the principal entrance, he arrives at two oblong courts, one of which is called the court of the lions, and is celebrated in Arabian history. A portion of the section of this court is given below. Round these two courts, on the ground floor, are disposed all the apartments of the palace; those for state look out towards the country; the rest, cooler and more retired, have small openings for light under the interior porticos, the whole of which are decorated with painted stucco, porcelain, and the most valuable marbles. On a neighbouring hill is another palace, called the Generalife: its ruins show that it was inferior to the Alhambra neither in size nor splendour. It is precisely in the same taste, and the details are similar, proving that the two edifices are contemporaneous.



Surprising as the works we have just named must be considered, we do not discover in them that real grandeur which exists in the works of the Egyptians, the Etrurians, the Grecians, or the Romans. The mode of construction, though sufficiently durable, is not scientific, as respects the working of the materials. Brick was the material most in use; the masonry, where employed, is covered with a coating of stucco, of which the painting in different colours is a great source of the admiration these buildings excite. The domes which crown their apartments are neither lofty nor large in diameter, neither do they exhibit great mechanical skill. The Moorish architects seem to have had no notion of raising vaults from lofty piers. In the mosque at Cordova, the span from pier to pier would have been less than 20 feet, to vault which would not have required very

extraordinary skill; yet here we find timber ceilings throughout. The use of orders seems to have been unknown to them; they employed the antique columns which they found ready to their hands, or rude imitations of them, without any apparent acquaintance with the types from which they were derived, their principles or proportions. Hence their columns may be more appropriately termed posts. In the forms of Moorish architecture we do not discover a character of originality arising out of local causes. The Arabians had wandered far from their country, in which they had never cultivated the arts; their architecture was, therefore, necessarily formed upon models which were before them, such as the degenerated Roman and Byzantine. The form of their arcades is confined to this style of architecture. They may be divided into two classes, both of them vicious in construction, from not affording the necessary resistance to thrust near the abutments. In masonry, failure would follow such forms, if practised on a large scale; but where arches are formed of brick, the large surface of cement used, if it be good and the centres not struck until the cement is set hard, allows great caprice in their forms. If the pleasure—we might almost use the word sensuality—of the eye be the sole object, it cannot be denied that success attended the efforts of the Arabian architects of Spain. The embroidery and painted draperies of the East appear to have been transposed to their architecture. The variety and profusion with which they used their ornaments, moreover, give their masses the appearance of a congeries of painting, incrustation, mosaic, gilding, and foliage. Much, perhaps, of this was induced by the law of their religion, which forbade the representation of animals or the human figure. It cannot be denied that in this profusion of ornament we find the details beautifully executed, and some of their forms extremely fine; and the mode of piercing domes for light, which they practised by means of starlike openings, is attended with an almost magical effect.

Architecture, *Mexican*.—The temples and other public edifices of Mexico do not appear to have deserved the high praises which Spanish authors have bestowed upon them. The great temple of Mexico, the most celebrated in New Spain, as far as can be gathered from the obscure and inadequate descriptions of it, has been represented as a magnificent building, raised to such a height that the ascent to it was by a flight of 114 steps; yet it was but a solid square mass of earth, faced partly with stone. Its base on each side extended ninety feet: it decreased gradually as it advanced in height, terminating at top in a quadrangle of about 30 feet, whereon were placed a shrine of the deity, and two altars on which the victims were sacrificed. All the other celebrated temples of New Spain resembled that of Mexico. The great hillock at Cholula, to which the Spaniards have given the name of temple, is not approached by steps, nor has it any appearance of stone. Perhaps it has never been more than a natural eminence of the ground.

The Spanish historians lead us to suppose that the palace of the emperor and the houses of the nobles exhibited some elegance of design and convenient arrangement: we have, however, no vestiges of these remaining, and, from the mode in which Cortes conducted the siege of Mexico, it seems likely that all the monuments of any importance were destroyed. Still, as at the period when Robertson wrote his History only two centuries and a half had elapsed, it seems impossible that in so short a time edifices of importance should have left no trace of their existence.

Architecture, *Roman*.—It can scarcely be said that the Romans had an architecture peculiar to themselves. That which we understand by the name is a modification, some call it a debasement, of the architecture of the Greeks. But, although they thus adopted a foreign form of ornamentation, they possessed a genuine architecture, which by borrowing from others they practically destroyed; and this was the architecture of the arch. Whence it came to them, is a question which we are not called upon here to answer; but the fact remains that, where they abstained from Greek decoration, their buildings exhibited the principle of arched construction carried out with a massiveness and strength which have rarely been equalled. It may possibly have been derived from Etruria; it may have been permanently established by an Etruscan dynasty in Rome, but it is quite certain that Etruria did not derive her architecture from Greece. But whether the Cloaca Maxima and other great Roman works give evidence of a great Etruscan dynasty or not, the fact remains that the arch became the principle of all genuine Roman construction. Hence the assertion that Christian architecture may be traced directly to the Greek must be taken with a qualification; and it becomes of the greatest importance for the clear understanding of subsequent architectural history to bear in mind that the distinguishing characteristic of the former was derived from the principle, the use of which Roman architects for so long a time did their utmost to conceal. Without a struggle, Rome submitted herself to the intellectual yoke of the Greeks. 'In those instances where the skeleton of a building is Roman, she did no more than foist on them a system of decoration entirely unsuited to its new application, and which disguised or concealed all that was great and splendid in her architecture. Where with Greek detail she unites their general design, the buildings are not, strictly speaking, to be considered Roman at all. She sacrificed, in fact, for the sake of foreign elegance her native sources of strength and grandeur, and cramped a constructive genius, which might otherwise have astonished the world with a more genuine and stupendous architecture of the arch than it has ever yet beheld. The capital and entablature of Greece were not only

features alien to her art, but fatal obstacles to any real display of her powers; nor could she retain them but at the expense of an absurd incongruity and a frequent concealment of her real construction. And when, having filled the world with the vast structures of her spurious art, she fell before the inroads of Northern barbarians, her architecture became in their hands the source of illimitable beauty and grandeur only by being gradually stripped of the ungainly and cumbersome garb with which she had so studiously concealed her living powers. Greece therefore bequeathed to Rome a number of decorative features; from Rome Christian architecture derived its essence and its life. The forms of Greek art could never have given birth to any style presenting a really different character but for their accidental association with a foreign construction, while the architecture of Rome must have issued in a more magnificent development, had that of Greece never come into existence; nay, it would have done so perhaps with greater certainty and rapidity.' (*Edinburgh Review*, January 1857.)

The necessary materials are wanting to enable us to follow up historically the state of the art during the ages of the republic. There is scarcely the vestige of a ruin of the period; it is, however, easy to form, either from the political state of the times, or from the encouragement given to the other arts, and especially to literature, some idea of the extent to which the architecture of the Romans flourished. The conquest of Greece by the Romans brought to their city not only an importation of works of art, but the artists themselves. In architecture, however, the Romans at this time had erected monuments of such dimensions as were beyond the means of the little and separated states of Greece. The new state of things brought to its aid all that it needed. The great use which at this period was made of the Corinthian order, is one of the proofs of the public and private wealth. From the time of Augustus we see the extent to which richness of detail was carried. A small portion of the Baths of Agrippa, known to us under the name of the Pantheon, enables us to appreciate the art of this period, though it is now despoiled of the bronzes of its pediment, its gilt caissons, and the profusion of sculptures that adorned it. In the time of Augustus, Rome was not only the capital of the world, but the world itself; it possessed within itself all the food that was necessary for the nourishment of the art. Rome now began to raise monuments of a description unknown to the Grecians—triumphal arches, baths as large as cities, immense porticos, amphitheatres, and naumachiæ. The marbles of all the quarries of the then known world were almost exhausted in supplies, and even Egypt furnished the city with means of adding to the general magnificence. Applied to such new species of edifices, it would have been indeed surprising if architecture had preserved its original Greek purity. It was the medium for satisfying a vanity which knew no bounds, and was ultimately obliged to gain its end more by effect than purity, by richness and exuberance of ornament rather than by harmony, and by grandeur of lines rather than by beauty of forms.

The luxury in art induced by the sculptor added to the number of different combinations in the Corinthian capital: this was carried to an excess which in the end produced a new order, known by the name of the composite. Thus, Roman architecture having, says Quatremère de Quincy, exhausted all the resources of richness guided by taste in the use of ornaments, throws aside all sobriety, sacrifices the whole to details and accessories, covers all parts of the surface without distinction, loads the different members with ornaments and sculptures, like a person who, to decorate a piece of cloth, covers it entirely with embroidery.

We close this article with a few remarks on the Doric order. This, in Greece itself, at the time of her subjugation, had begun to be affected by change. It had lost much of the primitive simplicity of its character and the severity of its principles. The various wants in edifices less simple in plan, a taste for elegance and richness which was found in the other two orders, tended to modify its forms and profiles. Thus, in the portico of Augustus at Athens, it was strangely changed in appearance. In Rome it was adopted with proportions still more slender, and an aspect infinitely less severe.

Architrave (made up from the Greek ἄρχω, *to rule*, and the Latin trabs, *a beam*). The lower of the three members of the entablature of an order, being, as its name imports, the chief beam that is employed and resting upon the columns. A French writer has styled it the foundation of the head of an edifice. The architrave sometimes receives the name of Epistylium, from the Greek words ἐπί, *upon*, and στύλος, *a column*.

Archives (Lat. archivum, from the Greek ἀρχεῖον, *a senate-house*). The repositories of the public records of a state or community: sometimes the records themselves are so called.

The English archives have been in the course of the last few years gradually removed from the various depositories in which they had hitherto been kept, and accumulated in the Public Record Office, Chancery Lane, under the superintendence of the Master of the Rolls. In the twenty-fourth annual report of the Deputy Keeper of the Public Records (1863), will be found at p. iii. a table comprehending the classes of public muniments which that office now contains. And in the twenty-fifth annual report, p. xxi., will be found a list of 'Records not yet received into the Public Record Office,' chiefly on account of insufficient accommodation for the present.

Archivolt. In Architecture this term is applied to express the ornamented band of mouldings round the voussoirs, or arch-stones, which terminate horizontally upon the impost. The archivolt is decorated analogously with the

architrave, which it may be said to replace in arcades, or in a series of arches.

Archlute. A double-stringed theorbo, for the bass parts, and for accompanying the voice. It had fourteen notes, and considerable power. Handel employed it in many of his operas.

Archon (Gr. *a ruler*). The title of the chief magistrate of Athens. The office was originally instituted, it is said, on the death of Codrus, the last king of Athens, and was vested in one person who enjoyed it for life, and was succeeded by his son. Its duties were those of a limited monarchy, accountable to the assembly of the people; its duration was afterwards limited to ten, six, and, finally, one year, when its functions were divided among nine persons, taken at first by suffrage, and afterwards by lot, from the nobles. One was chief among them, and was called Eponymus, or naming Archon, because the year was distinguished by his name. The second, or king Archon (βασιλεύς), exercised the functions of high priest. The third, or Polemarch, was originally the chief military commander. The other six were called Thesmothetæ, or setters forth of the law, whose duties consisted chiefly in receiving informations and bringing cases to trial in the courts, and in an annual review of the whole body of laws, for purposes of amendment or abrogation. The exclusive right of the nobles to this office was taken away by the measures of Cleisthenes, who threw it open to the people at large. *See* especially Boeckh's *Public Economy of Athens.*

Arcograph (Lat. arcus, *a bow*, γράφω, *I write*). A drawing instrument for describing arcs of circles, or other curves, without centres.

Arctic (Gr. ἀρκτικός, from ἄρκτος, *the bear*). An epithet given to that part of the heavens in which are situated the constellations of the Great and the Little Bear. *Arctic Pole*, the north pole of the heavens, or the northern extremity of the axis of the diurnal motion. *Arctic Circle*, in geography, denotes a small circle of the sphere parallel to the equator, and 23½ degrees from the north pole. At this latitude, the sun, at the summer solstice, comes exactly to the horizon at midnight, without descending below it. The corresponding circle in the southern hemisphere is called the *Antarctic*. The arctic and antarctic circles separate the frigid from the temperate zones.

Arctic Current. The current thus named is considered to originate in the ice of the Arctic seas, whence it runs along the eastern shore of Greenland and round Cape Farewell to the western shore of Greenland in N. latitude 66°, when it turns southward, forming the *Hudson's Bay Current*. Thence it passes between the Bank of Newfoundland, and meeting the Gulf Stream, crosses it as an under current flowing into the Caribbean Sea. Another portion passes along the coast of North America and reduces the temperature of the land. The Arctic current, which is cold, replaces the warm water removed by the Gulf Stream.

Arctic Ocean. The portion of the great ocean contained within the Arctic circle. The area is estimated at between three and four millions of square miles, a very large part of which is covered with ice during the greater part of the year. The lands of Europe, Asia, and America approach by various promontories, and are almost connected by several chains of islands in this ocean, but there is now known to be open water at some parts of some seasons, connecting the Pacific with the Atlantic. The land does not appear to reach the north pole in any part, nor is the elevation of the Arctic land very great. In this respect the Arctic is very different from the Antarctic circle, and the climate of the North temperate zone is quite distinct from and much milder than that of the South temperate zone under similar conditions.

Arctium (Gr. ἄρκτος, *a bear*). A native Composite plant, forming a coarse troublesome wayside weed, with large rhubarb-like leaves, and burr-like flowerheads. It is called Burdock, and medicinal virtues have been ascribed to it. The common species is *A. Lappa*.

Arctizite. Wernerite. [SCAPOLITE.]

Arctomys (Gr. ἄρκτος, *bear*, μῦς, *mouse*). The name of the subgenus of *Rodentia*, or gnawers, including the marmots.

Arcturus (Gr. ἀρκτοῦρος). A star of the first magnitude in the constellation of Bootes, designated in the catalogues as α Bootes. It has a sensible proper motion.

Arcuation (Lat. arcuatio). An obsolete term for the mode of propagating trees by layers, the shoots being bent.

Ardassines. A very fine kind of Persian silk.

Ardea (Lat.). The name of a Linnæan genus of *Grallæ*, or wading birds, characterised by a straight, sharp, long, subcompressed bill, with a furrow extending on each side, from the nostrils to the apex of the bill. The genus was subdivided by Linnæus into the *Cristatæ*, corresponding to the modern genus *Anthropoides*; the *Grues*, or cranes; the *Ciconiæ*, or storks; and the *Ardeæ*, or herons; which latter have been subsequently subdivided into *Ardeæ*, or herons proper; *Nycticoraces*, or night-herons; and *Botauri*, or bitterns.

Ardent Spirit. [ALCOHOL.]

Ardisiaceæ (Ardisia, *one of the genera*). Exogens, which might, without much inaccuracy, be termed woody primulaceous plants. They form herbs and trees in warm countries, and have a succulent fruit; but they really differ in scarcely any positive point of structure from *Primula* and its co-ordinates. The group is now more usually called MYRSINACEÆ: which see.

Are. The modern French measure of surface, equivalent to 100 square mètres. Its multiples are called decare, hectare, chilare, miliare, &c., equal respectively to 10, 100, 1,000, 10,000, &c. ares; its sub-multiples are termed deciare, centiare, milliare, &c., equal respectively to $\frac{1}{10}$, $\frac{1}{100}$, &c. of an are. The hectare is the term most frequently used and,

compared with English measure, 1,000 acres are very nearly equal to 404⅔ hectares. [ACRE.]

Area (Lat.) In Embryology, certain definite spaces which successively arise in the germinal membrane are so called: thus the opaque spot produced by an accumulation of cells and cell-nuclei is called 'area germinativa,' or germinal area; the clear space which subsequently appears in its centre is called 'area pellucida;' and the outer part of this space, where the blood-vessels are first formed, is called 'area vasculosa.'

AREA. In Mathematics, *quantity of surface*; the term, however, is usually restricted to plane figures. In measuring areas the unit is the area of a square described on the unit of length: the *number* of such unit squares which, taken together, cover the same quantity of surface as a given figure is the area of the latter. Hence the word *quadrature*. A triangle being half that of a rectangle having the same base and altitude, is equal to half the product of the lengths of its base and perpendicular. The area of any rectilineal figure is found by dividing it into triangles. The area of a figure bounded by a curve is found by the integration of $y\,dx$, where x and y, the rectangular co-ordinates of any point of the curve, are expressible as functions of a single variable by means of the equation to the curve. [QUADRATURE.] Practically the area of such a figure is found by first constructing a rectilineal figure of, approximately, the same area. [SURVEYING and OFFSET.] Mechanically, the area of any plate or disc of uniform density and thickness is found by dividing its *weight* by that of the unit square cut out from the same plate.

Areæ. In Entomology, the larger longitudinal divisions of the wing: they are termed cretal, intermediate, and anal, according to their relative position.

Areca (Areec, *the Malabar name*). An East Indian Palm tree, whose nuts, folded in the leaf of the *Piper Betel*, and mixed with a little lime, are chewed by the natives of the countries bordering on the Indian Archipelago as a stimulating narcotic.

Arena. A Latin word, signifying in its original meaning sand; but applied in a secondary sense to that part of the amphitheatre where the gladiators fought, which was covered with sand; the word is sometimes applied to the whole amphitheatre, or to any place which is habitually resorted to by combatants.

Arenaceous (Lat. arenaceus). That which possesses the properties of sand; it is used with reference to certain descriptions of stone which have the texture of loose friable varieties of sandstone, cemented by some extraneous matter.

Arenaceous Rocks. Rocks in which sand forms a principal ingredient. Loose and uncompacted sands are also called in geological language arenaceous rocks, and are classed with sandstones.

Arenaria (Lat. arena). A genus of wading birds, wanting the hinder toe: of this genus there is but one British species—the Sanderling. In Botany, the name given to a small genus of *Caryophyllaceæ*.

Arenation (Lat. arena). The cure of diseases by sprinkling hot sand upon the body.

Areola (dim. of *area*). The ring or margin which surrounds the pustule of small and cow pox.

Areolæ. In Entomology, are smaller spaces into which the wing is divided by the nervures: they are termed vasal, middle, and apical, according to their relative position.

Areolar Tissue. In Anatomy, a term synonymous with CELLULAR TISSUE, which see.

Areolate. In Entomology, divided into small spaces, or areolations.

Areolation means any small space, distinctly bounded by something different in colour, texture, &c. The spaces of parenchyma, which in leaves are bounded by veins, are called areoles or areolations.

Areometer, or **Aræometer** (Gr. ἀραιός, *thin*, and μετρόν, *measure*). An instrument for measuring the density or specific gravity of fluids. [HYDROMETER.]

Areopagus. The chief court of judicature at Athens: so called because it met in a hall on an eminence, called the Hill of Ares (Ἄρειος πάγος). This court, which was of very early origin, was raised to the high character it afterwards enjoyed by Solon, who appointed that it should consist of the archons who had undergone with credit the scrutiny they were subject to at the expiration of their office, and added to its jurisdiction in cases of wilful murder, wounding, and arson, extensive powers of a political and censorial nature. These powers were much reduced by the measures of Pericles and his partisans. For the character and extent of the changes so introduced, see Thirlwall, *History of Greece*, iii. 24, and Grote, *History of Greece*, part. ii. ch. xlvi.

Arendalite. A variety of lime-and-iron Epidote, from Arendal in Norway.

Ares. In Greek Mythology, the name of one of the Olympian gods, who in some versions of the myth is a son of Zeus and Hêrê. In the *Iliad*, he is represented as of huge size, his body covering seven plethra; in the lay of Demodocus, in the *Odyssey*, he is the lover of Aphrodite. The Romans identified him with their god Mars. [MARS.]

Arethusa (Gr. Ἀρέθουσα). In Mythology, one of the Nereids, who gave her name to the famous fountain in the island of Ortygia, near Syracuse.

Arfvedsonite. A black, opaque variety of Hornblende, containing a large proportion of iron, and also soda, found in Greenland and Norway. Named after the Swedish chemist Arfvedson.

Argand Lamp. The application of a circular wick to oil lamps, so contrived as to allow of a current of air both inside and outside, was originally patented by a person of the name of Argand: the contrivance constitutes an important

epoch in the history of the improvement of lamps; by it the amount of light derivable from a given quantity of oil was enormously increased. The same principle is applied to gas burners. [LAMP.]

Argel, or **Arghel.** The Egyptian name of the leaves of the *Cynanchum oleæfolium*, now called *Solenostemma Arghel*, which are mixed with senna leaves.

Argemone. A small genus of *Papaveraceæ*, sometimes found with the aspect of thistles and the flowers of poppies. *A. mexicana* is a yellow-flowered species, whose seeds are emetic and purgative, and have been used as a substitute for ipecacuanha.

Argent (Fr. from Lat. argentum, *silver*). In Heraldry one of the metals employed in blazonry: it is equivalent to pearl among precious stones, Luna among planets. In engraving it is represented by a plain surface.

Argentina. A Linnæan genus of abdominal fishes, belonging to the salmon family; characterised by a small mouth, without maxillary teeth; the tongue armed with curved teeth; and a transverse row of small teeth on the vomer; branchiostegal rays, six. The argentines rank in the order *Malacopterygia*, or soft-finned fishes of Cuvier. The name is derived from the silvery glistening appearance in the scales of these fishes.

Argentine (Lat. argentum, *silver*). A kind of carbonate of lime with a silvery-white lustre, and a slaty structure.

Argentite. A name for sulphide of silver or Silver-Glance.

Argentometer. A graduated tube used for ascertaining the amount of silver in a solution by the admission of a definite bulk of choride of sodium solution.

Argillaceous (Lat. argilla, *clay*). That which has the properties of clay. Some of the limestones are said to be argillaceous when they contain as much as 10 or more per cent. of clay in their composition: some of the ores of iron are also said to be argillaceous when that ingredient is present in marked proportions. The presence of clay generally communicates a conchoidal fracture to the ore, or the mineral.

Argillaceous Rocks. Rocks of which CLAY is the prevailing ingredient. Not only clay in the ordinary sense of the word, but SHALES and SLATES come under this description, and will be found described under separate headings. Many argillaceous rocks contain other minerals Thus, clays mixed with sand form loam; with limestone they form marl; with carbonate of iron they form clay-ironstone.

Argo. So called from the mythical ship Argo, a very extensive southern constellation, usually divided into four: Argo, Argo in Carina (in the keel), Argo in Puppi (in the stern) and Argo in Velis. A great part of the constellation is invisible in our latitude; it has one star of the first magnitude, Canopus.

Argol. The tartar of wine.

Argonaut, Argonauta. Applied by Linnæus, in the singular number, to the testaceous cephalopod designated by Aristotle and the ancients Nautilus, and commonly called at the present day the Paper Nautilus, from the fragile nature of the boat-like shell in which the inhabiting cephalopod occasionally floats on the still seas of the warmer latitudes. Many modern naturalists limit the application of the term argonauta to the shell, supposing that its true constructor is yet to be discovered, and that the cephalopod which has hitherto been exclusively found in it, is a parasite. [OCYTHOE.]

Argonauts. In Greek Mythology, the name given to the chieftains who accompanied Jason in the ship Argo on his expedition to Colchis, to recover the golden fleece of the ram, which had borne Phryxus from Orchomenos to the palace of Æetes. For an analysis of the myth see Grote, *History of Greece*, vol. i. Part i. ch. 13.

Argument (Lat. argumentum). In Astronomy, denotes the angle or quantity on which a series of numbers in a table depends. For example, suppose a table were formed showing the amount of horizontal refraction at every degree, &c., of altitude; then the altitude would be termed the argument of the refraction; and the table is said to be entered with the argument.

ARGUMENT. In Logic, an expression in which, from something laid down as granted, (i.e. the premises), something else (i.e. the conclusion) is to be deduced. In ordinary discourse, the word is very often used for the premises alone, in contradistinction to the conclusion; e.g. 'the conclusion which this argument is intended to establish, is, &c. &c.' It is also sometimes employed to denote what is, in strictness of speech, a *course* or *series* of arguments: it is in this sense that we speak of 'Warburton's argument to prove the divine legation of Moses.' The word is also frequently used to express what may be properly called a disputation: i.e. two trains of argument opposed to each other, as when it is said that A and B had a long argument on any subject, and that A had the best of the argument. (Vide Whately's *Logic*, p. 300.)

ARGUMENT. In Mathematics, the term argument is often used to denote the independent variable upon whose value that of a function depends. [ELLIPTIC FUNCTIONS.]

Argyllite. A mineral lately discovered by Mr. Lewis Thompson, in very small quantities, on a nickel mine on the estate of the Duke of Argyle at Inverary, and near Fowey in Cornwall. It is a compound of lead, vanadium and sulphur, consisting of 60·8 per cent. of lead, 20·5 vanadium and 17·7 sulphur. The colour is a dark lead-grey resembling that of Galena, with considerable lustre, and it occurs in minute rhombic dodecahedrons with a specific gravity of 6·04.

Aricina. An alkaloid discovered in 1829, by Pelletier and Coriol, in a bark from Arica, resembling a species of cinchona.

Ariadne (Gr.). In Greek Mythology, a daughter of Minos, king of Crete, who, when forsaken by Theseus, at Naxos, became the wife of Dionysus. The name of her mother, Pasiphaë, like that of Telephassa, the mother of Cadmus, connects the myth with the great body of solar legends. (Max Müller, *Comparative Mythology*; Cox, *Thebes and Argos*, *Introduction*; Bréal, *Hercule et Cacus*.)

Arians. The followers of the theological opinions of Arius, a presbyter of the church of Alexandria in the fourth century, who denied the equality of the Father and Son, and is generally considered as the author of a system which continued, under various modifications, to exercise the most extensive influence upon the Christian world of any heresy of ancient times. It was in the year 319 that these views were first promulgated at a meeting of the clergy of Alexandria; and their author, after some delay, was excommunicated by the patriarch Alexander. The progress, however, which the opinions continued to make, excited, after a few years, the notice of the emperor Constantine, who addressed a letter to Alexander and Arius jointly, in which he attempted to attain the object for which on other occasions he resorted to more violent methods, that of reconciling the conflicting parties upon whatever basis, and securing harmony at all events. At the earnest desire, however, of the orthodox party at Alexandria, he convened the general council of Nicæa, which assembled in the year 325, and proceeded to institute a full investigation into the matter in dispute. On this occasion the Nicene creed was drawn up, in which the clause which principally affects this subject is the assertion of the consubstantiality of the Son with the Father, or the Homoousion. This the Arians would not concede. A middle party arose under Eusebius of Nicomedia, who proposed, but without effect, the term Homoiousios, asserting, not the identity, but the similarity of substance. This, which is generally denominated the Semi-arian scheme, satisfied neither the Catholics nor the Arians, who from their rejection of it acquired the title of Anomoioi. The Catholics triumphed, and their opponents submitted to the decree of the emperor which required them to acknowledge the creed propounded for their acceptance. From this time, according to some writers, the Eusebians became a mere political party, who endeavoured to preserve the favour of the prince, for which they had already made the greatest of sacrifices, by a repetition of similar unworthy arts. At this period another Eusebius, the courtly bishop of Cæsarea, and celebrated historian of the Christian church, became one of the leaders of this branch of Arianism. His talents and ingenuity are represented as of singular service to the cause of the heretics, by inducing the emperor, after some delay, to command the restoration of Arius to the church of Alexandria, and the banishment of Athanasius. A day was appointed, upon which Alexander, the aged bishop, should admit the still suspected heretic to the holy communion: his protestations of orthodoxy were such as to satisfy the prelate that God only could discover his real sentiments, and he solemnly declared that in His hands he left the matter. In the midst of the fears and scruples of the one party, and the anticipated triumph of the other, the proceeding was suddenly terminated by the death of Arius, an event in which the Catholics discovered a signal interposition of God, but which the heretics confidently ascribed to assassination by poison.

Aries (Lat. *the Ram*). The first constellation of the ancient zodiac. Aries also denotes the first sign or the first 30 degrees of the zodiac; the first point of Aries being the point in which the equator intersects the ecliptic, and from which the longitudes are reckoned. In ancient times the signs and constellations of the zodiac coincided; but owing to the precession of the equinoxes, the twelve signs go backward among the constellations, at the rate of about 50″ annually, and the first point of Aries is now situated in the constellation Pisces.

Aries. In ancient Military Science, the Latin name of the battering ram, an instrument with an iron head used to batter and beat down the walls of besieged places.

Arika. A spirit made from fermented milk.

Aril (Arilla, in Low Lat., *a piece of red cloth*). In Botany, a membrane, either fleshy or otherwise, originating from the placenta, and growing over a seed either partially or entirely. Instances of it occur in the Nutmeg, where it constitutes mace; and in the *Euonymus europæus*, where it is a red succulent membrane. It is remarkable that this part, the use of which is unknown, never appears till after the young seed is fertilised.

Arioso (Ital.). A term sometimes applied to a short solo in an oratorio or opera, somewhat in the style of an air, but not so long.

Aristocracy (Gr. ἀριστοκρατία, from ἄριστος, *the best*, and κρατέω, *to govern*). According to the acceptation in which the word is used by ancient writers, a government in which all the *best* citizens of the state, i.e. those excelling either in hereditary distinction or in wealth, ruled their fellow-citizens. When the power was in the hands of a small class of these, who had acquired it by chance or usurpation, such a government was said to be an oligarchy. Thus aristocracy is enumerated by Aristotle among the distinct forms of government; oligarchy is only mentioned as a perversion of aristocracy: and the distinction as taken by him is, that in an aristocracy the governors rule for the public good, and in an oligarchy for their own. In modern times, those governments have usually been termed aristocratic in which a small privileged class of noble or wealthy persons either governed absolutely, or shared the government in various proportions with the sovereign or with the people. Thus the Republic of Venice presented the purest example of an aristocracy among the older governments of Europe: while the government of the United Provinces, before the French Revolution, might

also be cited as an instance of an aristocratic commonwealth; and Great Britain of a monarchy tempered by aristocracy. In a stricter sense, however, the word has been used by modern speculative politicians to signify any government in which 'a minority of adult males' constitute the ruling class. In this sense, the government of France, that of England both in respect of the House of Commons and of the House of Lords, and, in short, almost every state in which a census is adopted as the qualification of those who elect representatives in the national assembly, must be cited as aristocratic. The word aristocracy is also frequently used to signify a class of persons in the state: the wealthy and noble classes in a body, or the latter class by itself.

Aristolochia (Gr. ἀριστολοχία, from ἄριστος, *best*, and λοχεία, *childbirth*). A genus of Exogenous plants, usually having twining stems, and one-sided, bent yellow or purple variegated flowers, the odour of which is often very offensive. They are stimulants and aromatics. One species, but not a twining one (*A. Clematitis*, the common Birthwort), is occasionally met with wild in England; a few are natives of the south of Europe, but the principal part of the genus is tropical.

Aristolochiaceæ. The natural order of which *Aristolochia* is the type. *Asarum* [ASARABACCA] is the only other common genus associated with *Aristolochia*; but there are several tropical forms. The wood of this order is remarkable for growing without forming concentric zones, although undoubtedly exogenous.

Aristolochin. A non-azotised principle contained in the *Aristolochia Serpentaria* or Snake-root.

Aristotelian Philosophy. A bare outline of the philosophy of Aristotle is all that we can attempt to give within the limits of the present article.

There is perhaps no ancient philosopher, the full comprehension of whose system requires so extensive a knowledge of the works of his predecessors in scientific research, and so careful a collation of detached passages in his own writings, which are composed for the most part in a fragmentary and unmethodical manner, and an obscure and concise diction. The latter difficulty will be the more apparent, when we state the now unanimous opinion of the learned, that the works of Aristotle which remain to us are entirely of the *esoteric* class, intended, not for publication, but to serve as notes to the oral lectures which he delivered to the more instructed of his pupils. It requires no more than a cursory glance at the titles and the bulk of Aristotle's writings, to be convinced of the comprehensiveness of his views, and the daringness of his design. He divides the whole circle of knowledge into three great provinces, Metaphysics, including, as its instrument, Logic; Physics, under which term, in addition to the sciences ordinarily falling under that denomination, he embraces a great portion of the philosophy of the human mind, as the phenomena of sensation, memory, and fancy; and, thirdly, Ethics, or the science which treats of the conduct and duties of man, regarded both as an individual and as a citizen. His Logic is contained in his Categories, his treatise on Interpretation or the Nature of Propositions, his former and latter Analytics, and his eight books of Topics; to which may be added his work on the exposure of Sophisms. These form together what has been called the Organon of Aristotle; and seem intended as a preparatory discipline to the study of his Metaphysics. (See Aristotle's *Metaphysics*, iv. 3.) The Logic of Aristotle is, what it professes to be, an enumeration of the leading classes, or genera, to which all our notions may be referred; an account of the various methods by which we arrive at general propositions, and reason from these when formed; and a body of rules for the conduct of the understanding in going through these processes. [LOGIC; CATEGORY, &c.] Metaphysics is the science of being, as such; and herein is distinguished from physics, which considers only the modifications of being, and the changes to which they are subject. Each of the physical sciences has its own fundamental axioms, the truth of which it is compelled to assume: it is the province of metaphysics to verify these assumptions, and to discover their unity and connection. Aristotle's metaphysical system, though it may be said to owe its origin and many of its peculiarities to that of his great predecessor, Plato, yet deviates from it in many important respects. Both the one and the other admit the existence of a faculty, the sphere of which transcends the objects of sense: they differ as to the method by which this faculty is to arrive at its determinations. Plato seems to have thought, that in virtue of the necessary connection in which all conceptions stand to each other, we are able, so soon as we have awakened one idea in our consciousness, to arrive at the knowledge of all the rest. Aristotle, on the contrary, conceived all deductive science to be illusive which does not rest, for the truth of its fundamental principles, on a previous induction from particulars. Agreeably to this conviction, he begins his Ontological speculations with the consideration of the individual, as it presents itself in the world of sense. To the production of each separate existence, four causes are necessary: the material cause, the formal, the final, and the moving cause. The three latter, he seems to admit, are substantially identical, inasmuch as in Nature the end of a thing is that very thing itself in its completeness: while the moving cause may be conceived as the type pre-existing in the mind of the artificer, which is the same with the form which he communicates to the material. We should greatly misconceive Aristotle's meaning, if, as has sometimes been done, we identified his forms of things with their outward figure, or even with the notion of them apprehended by the understanding. The form

of a thing may be differently expressed, as the law of its being, the principle of life within it, which animates and gives an individual existence to the matter; which, on the other hand, without its presence, would remain a mere blank potentiality, destitute of all qualities, and therefore unintelligible and imperceptible. This distinction between matter and form reappears, under different names, in various portions of the Aristotelian philosophy, and is with him a solution of most of the difficulties in ontology and physics. He conceives it to be the only mode of explaining the possibility of a thing coming into existence, the difficulty of comprehending which had led the eclectic philosophers to deny any reality to outward phenomena. He himself conceives the universe to be eternal. With Plato, however, he strenuously asserts the existence of reason, as something immutable and universal: coeternal with, but unaffected by, the shifting phenomena of the world. He differs from that philosopher, in making the universal reason identical with God, instead of being, with its correlative being, a creation of the Divine energy.

Of Aristotle's strictly physical researches, though curious, and, in their day, instructive, this is scarcely the place to speak. In his treatises on the Soul, on Memory and Recollection, and on the Nature of Dreams, he has earned the perhaps still higher praise of having created the science of Psychology, and of having discovered the guiding clue to the explanation of our mental phenomena, in the principle of association.

The third great division of the Aristotelian philosophy, that which regards the relations of man as a 'social and political animal,' is comprised in the Politics, the Œconomics, the Nicomachean and Eudemian Ethics, and the books entitled the Magna Moralia. Aristotle regards the science of ethics as most intimately connected with that of politics. He repeatedly expresses his aversion from all speculations on merely ideal perfection; and his conviction that the practicable, under the existing circumstances of humanity, is the true object of ethical enquiry. Among the most influential of these circumstances on the conduct of an individual, is the constitution of the state to which he may belong; in the spirit, and according to the maxims of which he must act, if he would earn the praise of a good citizen. Not indeed that a good citizen and a good man are necessarily identical terms: they can only become so in the case of one who is a dutiful member of a rightly constituted commonwealth. The question necessarily arises, 'How is this perfect form of polity to be determined?' The answer is, that form of government is the best, which affords scope for the developement of the best part of our nature; in other words, which produces the best men. Out of this circle, Aristotle cannot be said to have fairly extricated himself. He has in some measure approximated to a definite rule of morality in the doctrine, that every virtue lies between two opposite excesses. It must, however, be confessed, that a certain degree of vagueness prevails in his ethical speculations: a vagueness of which he was himself conscious, and apparently despaired of satisfactorily removing. Perhaps the most valuable part of his moral writings, is that in which he discusses the much vexed question of the relation of happiness to morality. Pleasure, he determines, can never be taken as a measure of actions, inasmuch as it is the uniform concomitant of all natural action whatsoever. (*Eth. Nic.* l. x.) His Politics comprise a very careful review of the most celebrated Grecian constitutions, and a generalisation of the leading possible forms of government, with their various merits and defects, built on a careful induction from the great mass of varied facts and instances with which the history of his country supplied him. They are consequently invaluable, alike to the curious in Grecian history, and to the political theorist; and traces of their effects are sufficiently visible in the writings of perhaps all who have arrived at eminence in the latter department. See further, the article 'Aristoteles,' in Smith, *Dictionary of Greek and Roman Biography and Mythology*.

Among the editions of Aristotle's complete works the most important are (1) that of Aldus, the editio princeps, Venice 1495–98, 5 vols. fol.; (2) that of Sylburg, Frankfort, 11 vols. 4to. 1584–87; (3) that of Bekker, 3 vols. 4to. Berlin, 1831. Of the *Ethics*, those of Michelet, with a commentary, 2 vols. 8vo. Berlin, 1835; and of Cardwell, Oxford, 1828, 2 vols. Of the *Politics*, those of Schneider and Göttling. Of the *Treatise de Animâ*, with copious notes, that of Trendelenburg. Numerous editions of the *Rhetoric* have been published in Oxford. Of his ancient commentators the best are Ammonius, Alexander Aphrodisiensis, Simplicius, and Thomas Aquinas.

Arithmetic (Gr. ἀριθμητική). The 'art of numbering' or science of number. In the ordinary and restricted acceptation of the term, however, arithmetic is the art of expressing numbers by symbols, of combining these symbols, and of applying to them the several rules of greatest practical utility.

For the history of arithmetic, the reader may be referred to the elaborate article on the subject in the *Encyclopædia Metropolitana*: here we must limit ourselves chiefly to the science in its present state.

In the expression of numbers the great advantage of our arithmetical notation consists in the fact that every symbol has a *local* as well as an *intrinsic* value. The intrinsic value of a symbol is the number it represents: the *local* value depends, *first*, upon the number of symbols used, and, *secondly*, upon the position of that symbol with respect to the accompanying ones. With respect to the second property, all systems of arithmetic are alike; the value of a symbol in any position, is as many

times that of the same symbol in the next following position as there are symbols employed. The number of symbols, one of which 0 has no intrinsic value, indicates the *scale of notation*, or rather the *radix* of that scale. Thus, in the binary scale of notation, where the symbols 0 and 1 are alone used, the number thirty-one would be expressed by 11111, for proceeding from right to left the several symbols 1 would have the values one, two, four, eight and sixteen. The successive symbols, in fact, represent the several powers of the radix (two) of the scale. Again, 110101 would express the sum of the fifth, fourth, and second powers of two increased by unity, that is to say, the number fifty-three. A *binary arithmetic* of this kind was, in fact, proposed by Leibnitz; for, although it would be inconvenient for common purposes, it has advantages when investigating the properties of numbers. Again, in the quaternary scale of notation, the symbols 0, 1, 2, 3, would suffice for the expression of all numbers. The above number, fifty-three, for instance, would now be expressed by 311; for, proceeding from right to left, the symbols here used would denote the numbers one, four, and three times sixteen respectively.

In the ordinary or *decimal* arithmetic, which had its origin, probably, in the ten fingers of the hand, and came to us from the Hindus, the ten symbols or *digits* 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, are employed, and we extend the Hindu method by writing symbols to the right of the units place to indicate tenths, hundredths, &c., taking care to separate whole numbers from fractions by a point called the *decimal point*; thus 103·45 indicates one hundred and three units, four tenths, and five hundredths.

In *duodecimal* arithmetic, which is still occasionally employed, the want of two new symbols for *ten* and *eleven* causes much inconvenience. In compound arithmetic, where with the same ten symbols we have in reality several scales of notation, the inconvenience is still greater, and the power and elegance of arithmetical computation greatly impaired.

In all these systems of arithmetic the rules of computation, though differing from one another according to the scale of notation employed, are deducible from the four fundamental ones of addition, subtraction, multiplication, and division. In fact, multiplication itself is merely an abridged method of repeatedly adding a number to itself, whilst division is a mode of ascertaining how often one number may be subtracted from another. The rules of involution, evolution, proportion, interest, discount, &c., which will be described in their proper places, are merely applications of the four fundamental rules above alluded to.

Arithmetic, Political. The application of arithmetic to researches connected with civil government, such as the number of inhabitants of a country, the quantity of food necessary for their consumption, the labour they can accomplish, the mean duration of life, the produce of the soil, the frequency of fires or shipwrecks, &c. In applying arithmetic to inquiries of this sort, we have three principal objects in view; the first is to procure precise facts, the second to deduce from the observed facts the consequences to which they lead, and the third to determine the probability both of the facts and the consequences. [Statistics.]

Arithmetic, Universal. The name given by Newton to algebra, or the calculation of magnitudes in general. The operations of ordinary arithmetic are founded on two distinct classes of principles; the first are independent of the particular signs by which numbers are expressed, the second depend on those signs. The general properties of numbers, which are independent of any particular system of notation, form the subject of universal arithmetic.

Arithmetical Complement of a number is what it wants of the next higher decimal denomination. Thus 4 is the arithmetical complement of 6, because it is what 6 wants of 10. In like manner 43, 578 and 13·46 are respectively the complements of 57, 422 and 86·54. The most expeditious way of finding the arithmetical complement is to begin on the left hand and subtract each digit from 9 except the last, which must be subtracted from 10. The arithmetical complement is convenient in calculating with logarithms.

Arithmetical Mean. The arithmetical mean of a series of numbers denotes the quotient obtained by dividing their sum by their number; thus the arithmetic mean of 1, 2, 7, 10 is $\frac{1+2+7+10}{4}=5$. The arithmetic mean between two numbers is equidistant from the latter. By the insertion of several arithmetic means between two numbers is meant the formation of an arithmetic progression whose extreme terms are the given numbers and intermediate terms the several means.

Arithmetical Progression. A series of three or more numbers (or fractions) each of which differs from that which precedes it by the same number and in the same manner. Thus, 3, 5, 7, &c.; 12, $10\frac{1}{2}$, 9, &c. and generally a, $a+d$, $a+2d$, &c. constitute three arithmetical series: in the last d represents the common difference, and may be a whole or fractional, positive or negative number. Of the five elements of an arithmetical series, viz. a the first term, z the last term, d the common difference, n the number of terms, and s their sum, any three being given the remaining two are found from the formulæ $z=a+(n-1)\,d$ and $s=\frac{n}{2}(a+z)=\frac{n}{2}[2a+(n-1)\,d]$.

Ark of the Covenant. A coffer containing the golden pot of manna, with Aaron's rod and the tables of the covenant, placed under the mercy-seat, and serving as the centre of the religious worship of the Jews. It was either carried to Babylon, or destroyed on the capture of Jerusalem by Nebuchadnezzar.

Arkansite. A name given to the thick

black crystals of Brookite, which occur at Magnet Cove, in Arkansas, N.A.

Armada (Span. from Lat. armatus, *armed*). This name is peculiarly applied in English history to the fleet assembled by Philip II. in 1588, for the conquest of England. The Spaniards, with their usual inflation of language, termed it 'Invincible.' It consisted of 150 ships, carrying 2,650 guns, and having on board 20,000 soldiers, besides volunteers, and 3,000 seamen. The history of its misadventures and dispersion is well known. The best Spanish account of the transaction will be found in Herrera.

Armadillo (Span. *armed*, dimin.). A Spanish epithet, applied to a genus of small South American macronykous or edentate quadrupeds, characterised by a defensive armour of small polygonal bony plates, which covers the head, trunk, and sometimes the tail. Linnæus applied to this genus the term Dasypus, by which the Greeks, with more propriety, designated the hare and rabbit.

Armament (Lat. armamentum). A force equipped for war, naval or military. In Roman antiquities, armamenta comprehended the rigging and tackling of a ship, its sails, sail-yards, oars, ropes, &c. Hence 'Arma' sometimes denotes the sails and the rudder of a vessel. (Virgil, *Æn.* vi. 353.)

Armatoli. A kind of national Greek militia, founded in the middle ages. They were dispersed with great cruelties by Ali Pasha of Yanina, in the latter part of the last century; but at the breaking out of the revolution, they issued forth from their native fastnesses in aid of their country's liberty.

Armature. A piece of soft iron applied to a loadstone, or connecting the poles of a horse-shoe magnet.

Armenian Church. The Armenians are Christians of the Eutychian or Monophysite doctrine, which recognises only one nature in the Saviour, viz. the Divine; and the procession of the Holy Ghost from the Father only. They hold the seven sacraments of the Romish Church, and the doctrine of transubstantiation: their clergy is also divided into secular and regular. From the wide dispersion of the Armenians over the commercial regions of the East, their form of Christianity is also considerably diffused, although it appears to be strictly a national church of which none but Armenians are members. Since the war between Russia and Turkey in 1829, the place where the principal of their four patriarchs resides (Etchmiadzine), has been transferred from the latter to the former government. There is also at Constantinople, and in other parts of the Levant, an Armenian Roman Catholic Church, owning the supremacy of the Pope. There is a well-known congregation of Armenian monks on the island of San Lazaro, near Venice, who have published a variety of useful works in the language of their country.

Armenian Stone. A commercial name for Lapis Lazuli.

Armiger (Lat. from arma, *arms*, and gero, *I bear*). In Heraldry, an esquire, or one entitled to bear arms.

Armilla (Lat. *a bracelet*). In Ornithology, the coloured circle of the distal naked end of the tibia, above the tarsal joint.

Armillary Sphere. An ancient astronomical machine, composed of an assemblage of hoops or circles, representing the different circles of the system of the world, as the equator, the ecliptic, the colures, &c., put together in their natural order, and occupying their proper relative positions.

Arminians. In Theology, those who hold the tenets of Arminius, a Protestant divine, born in Holland in the year 1560. They are thus summed up:—

1st. God from all eternity determined to save all who He foresaw would persevere in the faith, and to condemn all who should continue in unbelief.

2d. Christ atoned for the sins of all mankind, but those only who believe partake of the benefit of that atonement.

3d. Man is of himself incapable of true faith; therefore regeneration by the Holy Spirit, given of God through Christ, is necessary.

4th. All good works are to be attributed to the grace of the Holy Spirit, which, however, does not force a man against his own inclination.

5th. God gives to the truly faithful the means of continuing such. With respect to the possibility of a defection from this state of grace, Arminius and his immediate followers expressed themselves undecidedly; but it came afterwards to be considered a part of the character of Arminianism to affirm the possibility.

The assertors of these opinions in Holland were vehemently attacked by the Calvinistic party, which was prevalent at the time; and in 1610 the Arminians addressed a petition to the States of Holland for protection, from which they derived the name of Remonstrants. In the year 1618, nine years after the death of Arminius, the Synod of Dort (Dordrecht) was convened by the States-General, and a hearing given to both parties. The Arminian opinions were defended by Episcopius, divinity professor at Leyden; but his side complained that they were unfairly treated, and the conditions of the discussion violated to their prejudice. They were condemned by the Synod, and treated in consequence with great severity, being forbidden to exercise the ministry in public: many of them fled to Antwerp, France, and other quarters.

From this period their opinions underwent a considerable change; and the articles above stated, which seem little different from the tenets of the Lutherans, began to be so explained as almost to do away entirely with the idea of the necessity of succour from the Holy Spirit. From hence they proceeded to reject many matters of faith, and to simplify materially

the articles requisite for salvation. They proposed to draw up such a comprehensive and liberal scheme as should embrace all Christians, with the exclusion of the Romanists. They considered it sufficient that a man should receive the Holy Scriptures as the rule of faith, and allowed each individual to interpret them for himself, only adding thereunto the necessity of moral duties and good works. The Papists were excluded on the score of morality, as admitting the lawfulness of persecution.

There is no longer any particular sect to which the name Arminian is exclusively applied; but the opinions above stated are adopted in England by one branch of the Methodists, who follow therein the views of their founder Wesley, and by many individuals of the Church of England, and other denominations. The articles of the English Church have been represented by different parties as inclining both to Arminianism and Calvinism; and Whitby, and Taylor, bishop of Norwich, are among the most famous of her friends who have maintained the Arminian tenets.

Armistice (Low Lat. armistitium). In National Law, a truce or suspension of hostilities.

Armour (Lat. armatura). A term applied to those artificial means by which men either protect themselves or annoy their enemies, hence called defensive and offensive. *Defensive* armour includes those arms specially used for the defence or protection of the body, as cuirasses, helmets, &c. *Offensive* arms, or those used in attack, are of different kinds; 1. For cutting, such as the sabre; 2. For thrusting, such as the straight sword, the bayonet, pike, lance, &c.; 3. And lastly, for shooting, such as muskets, pistols, and cannon. The history of armour is identified with that of every nation; and an elaborate discussion of this subject would throw great light upon questions of mythology, poetry, jurisprudence and civil polity, and strikingly display the progress of civilisation. On this subject, the reader is referred to the work of Sir Samuel Meyrick (3 vols. 4to. London, 1824), which the student of the politics, arts, manners, and wars of antiquity and the middle ages, may consult with great benefit.

Armour-plated. [SHIP, ARMOUR-PLATED.]

Arms, or **Armorial Bearings.** In Heraldry, the name given to the devices borne on shields or coat armour. Family coats of arms are divided by heralds into perfect and imperfect. Perfect are: 1. Abstract, or warranted by regular descent. 2. Terminal, belonging to the brethren of the right line. 3. Collateral, borne by brethren of the heir male. 4. Fixal, in third degree by right line of male heirs. Imperfect are: 1. Granted by the king, with a lordship. 2. The gift of a king, derived by a herald. 3. The ensign of a Saracen won in the field. 4. Heir female of close branch. 5. Arms of bastardy.

Army (Fr. armée). A body of men organised and disciplined for military service, commanded by a chief or leader, with subordinate officers in regular gradation, and supported both in time of peace and war for the preservation of internal quiet and defence against foreign aggression. An army is generally divided into a certain number of corps, each consisting of divisions, brigades, regiments, battalions, or squadrons. When in the field it is formed into lines: the first is called the vanguard; the second, the main body; the third, the rear-guard or body of reserve. The middle of each line is occupied by the foot: the cavalry forms the right and left wing of each line, and sometimes squadrons of horse are placed in the intervals between the battalions. In the history of armies we may distinguish those of three different periods: 1. The ancient armies, which from the time of Sesostris downwards underwent a series of progressive improvements under the Persians, Greeks, and Carthaginians, till they finally reached a high degree of perfection under the Romans. 2. Those of the middle ages, the offspring of the feudal system, which, however well calculated to keep alive a spirit of ferocity, opposed a formidable barrier to the revival of the military art, from their contempt of discipline and utter lawlessness. 3. Those that have existed since the invention of gunpowder and the establishment of standing armies. Since the use of gunpowder there have been seven principal periods in the history of the military art. The first extends from the early part of the fourteenth to the end of the fifteenth century. The second begins with the campaign of Charles VIII. in Italy, and extends to the commencement of the wars in the Netherlands, comprising the wars of the French, Germans, and Spaniards in Italy. The third period comprehends the great war of independence, waged by the Netherlands, in order to shake off the yoke of Spain, and extends from 1568 to the general suspension of hostilities in 1609. The fourth period comprises the celebrated Thirty Years' War, and extends from 1618 to 1648. The fifth period comprehends the wars of the French in Italy, Germany, and the Netherlands, as well as the Northern and Turkish wars, and embraces the space of 90 years, viz. from 1648 to 1738. The sixth period includes the three Silesian wars, viz. from the beginning of the first Silesian war in 1740, to the breaking out of the French Revolution in 1792. During these several periods many improvements took place in the composition and discipline of armies; but these were destined to be far surpassed in the seventh and last period, which embraces the military systems and establishments of our own times. In the organisation of the Continental armies great uniformity prevails; but as these are inseparably connected with the political condition of the people, a consideration of their character belongs to the history of these various nations, to which we must refer the reader. The British army, like those of the Continent, is divided into cavalry, infantry, and artillery,

and these again into regiments and brigades; but in its composition and organisation an entirely different principle is adopted. While the Continental armies are recruited by conscription, and every officer must have served as a private or a cadet, or have acquired some knowledge of the military art in a preparatory establishment, the ranks of the British army are supplied by voluntary enlistment, and commissions are attainable by any British subject within prescribed limits of age who is successful in competing for entry into, and passes through the Royal Military College at Sandhurst; or, in the case of the Artillery and Engineers, the Royal Military Academy at Woolwich. Direct commissions are also given by the commander-in-chief.

The sovereign is the actual head and chief of the army, but she delegates her power to a commander-in-chief, who has supreme command and authority in all matters of discipline. The money for the pay of the army is voted annually by Parliament, which thus renders the use of the army for purposes of military despotism impossible. The estimates are prepared by the Secretary of State for War, under whose control the expenditure of this money is placed, and who acts in conjunction with the commander-in-chief in all matters concerning the welfare of the troops.

Arnica. A genus of composite plants, one species of which, *A. montana*, the Mountain Tobacco, a native of Central Europe, possesses acrid and stimulant properties. It is a dwarf herbaceous plant with large yellow-rayed flower-heads.

Arnicine. A bitter principle contained in the flowers of the *Arnica montana*.

Arnoldists. In Ecclesiastical History, the followers, or rather partisans, of Arnold of Brescia, who in the twelfth century was the first to raise his voice against the abuses and vices of the papacy. He acquired for a time considerable influence among the lower orders, and the tumults which were raised by his supporters caused great uneasiness in Rome, which was the chief scene of his proceedings. He was finally put down by an armed force, made prisoner, and burnt by Pope Adrian IV. Certain heretical notions on the nature of the Eucharist were charged against him; but the insurrection which arose under his auspices was clearly a political disturbance, and his harangues seem to have been directed rather against the morals than the tenets of the church which he attempted to reform.

Aroideæ. The *Arum* family; a synonym of *Araceæ*.

Aroma (Gr.). The characteristic odour of substances, especially the strong and peculiar odours of certain plants, whence the term *aromatic*.

Arpeggio and **Arpeggiato** (Ital.). In Music, the sounding the notes of a chord in quick and repeated succession, so as to imitate the harp.

Arpidelite. [SPHENE.]

Arquebusade (from arquebuse, *a hand gun*). An aromatic spirituous lotion, applied to strains and bruises, but originally invented as an application to wounds inflicted by an arquebuse.

Arquebuse, or **Harquebuse** (Fr. arquebuse, from Low Lat. arcubagia, *a musket-stock with a bow fixed to it*). A sort of hand gun, used by infantry before the invention of the musket. The word is used very loosely in old writers for every sort of fire-arms used by infantry. Gunsmiths are still called arquebusiers in France. In the German, Spanish, and Gascon infantry of the earlier part of the sixteenth century, the pike and arquebuse men were intermixed in the same ranks. The barbarous English words hackbut, hackbutteer, which we find in military language in the reign of Elizabeth, are derived from arquebuse, arquebusier. The arquebuse is said to occur first in the descriptions of the battle of Morat in 1476. Arquebusiers on horseback are mentioned in that of the battle of Fornovo, 1494.

Arquerite. A Silver Amalgam occurring in small octahedral crystals and in arborescent forms, at the mines of Arqueros in Chili. It contains about 86 per cent. of silver and 13·5 of mercury.

Arracacha. The South American name for an umbelliferous plant, the *Arracacha esculenta* of botanists; whose fleshy sweet roots are cultivated in Columbia and Jamaica, in the same way as parsneps and carrots in Europe. The roots are of large size, and in quality, when cooked, are between a sweet chestnut and a parsnep. Attempts to introduce it into common European cultivation have uniformly failed.

Arraché (Fr. from arracher, *to snatch*). In Heraldry, the representation of a plant torn up by the roots.

Arrack (Indian). A spirituous liquor, obtained by distilling the fermented produce of rice; but other spirituous liquors are called by the same name. Arrack has a very strong and somewhat nauseous flavour and odour, derived from a peculiar volatile oil which it contains, and which corresponds with that which gives a sickly and disagreeable taste to our corn spirit.

Arraignment. In Law, the arraignment of a prisoner on a criminal charge consists in calling him to the bar, and (in treason or felony) making him hold up his hand, or otherwise own himself to be the party charged, reading the indictment to him in English, and demanding of him his plea (guilty or not guilty), and entering it accordingly.

Arras. [TAPESTRY.]

Arreoy. A singular institution formerly existing in Otaheite and other Society Islands, which, it is asserted, involved infanticide for political purposes. It was first noticed by Capt. Cook, and is further described by Ellis, in his *Polynesian Researches*, vol. i. p. 311.

Arrest (Nor. Fr. arrester, Fr. arrêter, *to stop*). In Law, in execution of the command of some court of record or officer of

justice, may take place either in criminal or civil cases. 1. For treason, felony, or breach of the peace, any person may arrest without warrant or precept. Arrests by public officers may be made either with or without process. Any constable, or even private person, who has a warrant directed to him from a justice of the peace to that effect, may arrest for felony or misdemeanor; and, if the warrant was given without sufficient ground, the justice is responsible. Every warrant should be under the hand and seal of a justice of peace, and specify the day on which it was made out: it seems to be rather discretionary than necessary, although it is usual to specify the cause of arrest in the warrant. 2. Arrest in civil cases, for debt, is either after judgment obtained or before judgment obtained (arrest on mesne, i.e. intermediate, process). The latter was for centuries in England the ordinary mode of endeavouring to compel a debtor to satisfy his creditor. But at the beginning of the present reign (by statute 1 & 2 Vict. c. 110) this kind of arrest was confined to cases in which the creditor shows on affidavit reasonable ground for supposing that his debtor is about to leave the country. Arrest after judgment (under the writ entitled *capias ad satisfaciendum*) subsists where the debt exceeds 20*l.*: but the Insolvent Court [BANKRUPTCY] has power to deliver the debtor on terms imposed by the court. The same court has a power of its own to grant warrants for the arrest of absconding debtors until a writ of capias can be procured. (Absconding Debtors' Arrest Act, 1851.) As to the freedom of Members of Parliament from arrest, see May's *Parliamentary Law*, chap. 5.

Arrest of Judgment. In Law. [JUDGMENT.]

Arris. In Architecture, the edge of two surfaces meeting each other; or the line of meeting of two planes in a sharp edge.

Arrondée (Fr. arrondir, *to round*). In Heraldry, a cross consisting of segments of a circle.

Arrow-headed Writings. [CUNEIFORM LETTERS.]

Arrow-root. The commercial name of the starch obtained by washing the grated tubers of the *Maranta arundinacea*, which it yields to the amount of twenty-five to thirty per cent. It is sometimes adulterated with potato starch, and the fraud is not easily detected; it, however, gives a disagreeable flavour and smell, like that of the raw potato, and forms a less firm jelly with hot water than when the arrow-root is genuine. Various other plants yield a similar bland starch, to which the name of arrow-root is applied in different countries.

Arsenal (Ital. arsenale, perhaps from the Arab. dâr çanah, *a place for work*). In Military Engineering, an arsenal implies the place where ships of war can enter and repair any damage which they may have sustained at sea, or in action with the enemy; or where the army may resort for supplies in case it requires them. A good arsenal must then contain shops, or fabrics, for the repairs of vessels, with graving docks, basins, floats, &c.; it must contain the shops for making the guns or ammunition required, the gun-carriages, and the other implements of war; and storehouses for receiving these goods until they are wanted. Engineers are warmly divided as to the necessity of fortifying these establishments. England has some very complete arsenals; as also have France and Spain. Plymouth, Portsmouth, and Woolwich, may be cited as specimens of the first; Cherbourg, L'Orient, Brest, Ferrol, and Corunna, of the second of these works.

Arsenic (Gr. ἀρσενικός, *powerful*). A soft, brittle, and eminently poisonous metal, of a steel-grey colour; its sp. gr. 5·7. It volatilises, exhaling a strong odour of garlic, before it fuses, at a temperature of about 400° F., and is easily inflammable. It combines with oxygen in two proportions; and as both compounds are sour, and form salts with bases, they have been termed arsenious and arsenic acids: the former is composed of 75 arsenic and 24 oxygen, and the latter of 75 arsenic and 40 oxygen. Arsenious acid is more commonly known under the name of *white arsenic*, and is the usual state in which this poison occurs in commerce: it is obtained during the extraction of several of the metals from their ores, and is a white brittle semitransparent substance, having little taste, but is virulently poisonous. Its sp. gr. is about 3·7. It forms a dull white powder, and it is in this form that it is usually sold. When heated in the flame of a candle, it rises in a white poisonous vapour, and exhales, in consequence of its partial reduction, a strong garlicky smell. The solubility of white arsenic in water varies with its isomeric modifications; 100 parts of water at 60° dissolve about 0·95 of the vitreous, and 1·25 of the opaque acid, and at 212° 9·7 of the former and 11·5 of the latter. When these hot solutions are cooled down to 60°, 1·8 of the vitreous and 2·9 of the opaque are retained in permanent solution. White arsenic dissolves in the alkalies, and combines with the metallic oxides, forming a class of salts called *arsenites*: they are all poisonous. Of these the arsenite of potash is used in medicine, under the name of Fowler's mineral solution: it is employed in very small doses in the cure of agues, and is an effective remedy, but requires much care in its administration.

When white arsenic is taken as a poison, it produces violent spasmodic pains of the stomach and bowels, attended by a sense of heat, and constriction in the mouth and throat, an increased flow of saliva, tightness about the head, itching of the face and neck, and nausea. These symptoms are succeeded by vomiting and purging and excruciating pains; the pulse, at first full, hard, and frequent, sinks and becomes irregularly feeble, and clamminess of the skin, cold sweats, and convulsions precede death; or if the patient escape this catastrophe, it often happens that hectic fever,

paralysis, and mental and bodily debility attend him for the remainder of his days. It has destroyed the life of an adult in the small dose of two grains, and is equally fatal whether taken by the mouth or applied to a wound. After death the stomach and bowels are usually found inflamed, but often only slightly so; and it appears from Sir B. Brodie's observations, that this poison kills by some peculiar action upon the heart and nervous system. The treatment of persons thus poisoned consists in promoting the vomiting by an emetic, composed of a solution of 20 grains of sulphate of zinc in two ounces of water, aided by copious draughts of warm barley-water or gruel; but the most effective means of getting rid of the arsenic, is by the use of the stomach-pump, which, when immediately resorted to, has often saved the patient. The after-treatment requires much circumspection.

White arsenic is used in many of the arts, especially in colour-making, dyeing, and calico-printing, and in preparations for the destruction of vermin. In the small quantities in which it is sold to the public, it is directed to be coloured with soot, or indigo.

Arsenic acid is more soluble and sour, but not less poisonous than the arsenious acid. Its salts are called *arseniates*, and the arseniate of potash obtained by deflagrating a mixture of white arsenic and nitrate of potash is occasionally used in medicine: it is the active ingredient in the tasteless ague drop.

For the means of detecting arsenic, and for the treatment of cases of poisoning by it, the reader is referred to works on chemistry, toxicology, and medical jurisprudence.

Arsenosiderite. A hydrous arsenide of lime and peroxide of iron forming fibrous concretions of a yellowish-brown or golden colour, in a manganese bed at Romanèche in France.

Arsis and **Thesis** (Gr. ἄρσις, *lifting up*, θέσις, *laying down*). In Music, terms used in composition, as when a point is inverted or turned, it is said to move *per arsin et thesin*, that is, when it rises in one point and falls in another; properly speaking, it is the rise and fall of the hand in beating time.

Arson (Low Lat. arsio, *a burning*). At Common Law, signifies the maliciously and voluntarily burning the house of another. This offence is now defined and regulated in its various degrees by the stat. 24 & 25 Vict. c. 97, ss. 1—8. The subjects of arson are defined in the first eight sections of this statute, so as to include buildings of every description. Burning ships is penal under sec. 42 of the same statute; burning crops, &c. under sec. 16. The punishments vary according to the quality of the offence, the highest being penal servitude for life.

Art (Lat. ars). The application of knowledge or power to effect a desired purpose. The ancients divided the arts into 'artes ingenuæ,' 'bonæ,' or 'liberales,' and 'artes serviles.' Under the latter were comprehended the mechanical arts, because these were practised only by slaves. In modern times arts are divided into fine and useful, comprising under the former those which have not utility for their direct or immediate object; such as music, poetry, sculpture, &c. (For the history and description of the fine and useful arts, see the respective articles.)

Artanthe. A genus of *Piperaceæ*, consisting of woody plants with jointed stems, and formerly included among the peppers. *A. elongata* furnishes one of the articles known by the Peruvians as Matico, which is applied to the same uses as cubebs. It also supplies a valuable styptic, the rough leaves having the power of staunching blood.

Artemisia (Gr.). A composite genus consisting of bitter or stimulating plants, of which Wormwood, Southernwood, and Tarragon form a part.

Arteriotomy (Gr. ἀρτηρία, *an artery*, and τέμνω, *I cut*). The opening of an artery: this operation is occasionally performed upon the temporal artery, with a view of relieving inflammatory symptoms about the head.

Artery (Gr. ἀρτηρία). These vessels are usually found empty in the dead body, and were supposed by the old anatomists to be air tubes; they are ramifications of the aorta, and convey the florid blood with a pulsating motion to the different organs and parts of the body. [Aorta.]

Artesian Well. A kind of well in which the water is obtained by sinking, or boring, through an upper retentive stratum to a subjacent water-bearing stratum, the entering or supply ground of which is situated at such a level as to enable the water from it to flow over the surface of the ground, at the point where the well is made. The term is only correctly applied, when the water overflows, although it is frequently used to express deep wells, sunk merely through impermeable to permeable strata; it is derived from the name of the province of Artois, in French Flanders, where these wells have long been known; they seem also to have been used from time immemorial in Lombardy and in the Adriatic provinces of Northern Italy.

About the beginning of the present century much attention was called to the subject of Artesian Wells, by the remarkable success of some operations of that description in the valley of the Thames, near Waltham and Tottenham, and in the valley of the Wandle near Merton and Garratt. At the commencement the water in these wells was found to flow over the surface, and even at the present day this continues to be the case with some of the wells in the valley of the Wandle; but the number of wells sunk through the London clay into the sands between that formation and the chalk has been so great, that the normal supply of the water-bearing stratum has not been equal to the demand upon it, and the water level has been constantly lowered of late years in the London wells, so as, in fact, to destroy their Artesian character. The same result took place

in France, especially in the Paris tertiary basin, where many wells were also sunk about this period; and it was on this account that M. Arago recommended the municipality of Paris to seek a fresh source of supply, by passing through the whole body of the chalk, until the permeable strata of the lower greensands were encountered. From the levels at which the lower greensands outcropped above Paris, M. Arago inferred that the water they contained would rise considerably above the surface of the ground at Paris itself; and the result of the great experiment tried at Grenelle, under his directions, was to substantiate his theoretical reasoning on the subject. This well, commenced in 1833, was carried to the depth of 1,806 ft. 9 in.; and on February 26, 1841, the water-bearing stratum of the lower greensand was reached, whence the water rose to the height of 122 ft. above the surface of the ground at Grenelle. Since the execution of this successful boring, many attempts have been made to obtain a supply of water by similar means; but the failures have been so numerous as to induce prudent men to regard the first essay of the system of Artesian boring, in an untried district, purely as a matter of experiment. The circumstances attending the failure of the Highgate, Harwich, Ostend, and Calais wells, show that, although certain strata may outcrop all round a particular place, it by no means follows that those strata should form continuous basins under that place; so that there is no certainty of the uninterrupted passage of the water under the superficial retaining stratum. The Southampton and the Chichester wells were both abandoned before the geological conditions of those localities had been ascertained; and the results of the Brighton well prove that, in the two instances last named, a further amount of perseverance would have been rewarded. Geology, however, can only assure us of what we shall *not* find under certain circumstances; it can never tell us what we *shall* find; and therefore, until a certain district shall have been made the subject of actual experiment, it is impossible to say whether, or not, it be possible to secure in it a supply of water by means of Artesian wells. The theoretical conditions required to warrant the belief in the probable existence of such a supply are:—1st, the existence of a mass of impermeable material, surrounded by a permeable stratum, whose lowest point on the exposed surface should be above the level of the point where the well is proposed to be sunk; and 2nd, that the mass, or cubical capacity for water, of the permeable stratum should be sufficient to meet the demands upon it. These conditions have been found to exist in the Great Desert of Sahara, and no less than fifty Artesian wells had there been executed up to the month of June, 1860, which were fed by the waters falling on the exposed edges of the permeable strata of the Atlas chain, passing subsequently under the clay, and the fissured sandstones of the Desert itself. Many very important and deep Artesian wells have been executed in northern Germany for the purpose of bringing to the surface the brine springs of that part of Europe; and the petroleum wells of the United States and of Canada seem to be of the same technical description. The most celebrated Artesian well, recently executed, is the one at Passy, in the neighbourhood of Paris, fed from the same strata as the well of Grenelle: the Passy well is about 1,923 ft. deep from the surface of the ground; the water flows over the surface at the rate of 5,582,000 gallons per day, and rises to a height of about 54 feet above the ground. The well was bored by M. Kind of the enormous diameter at the bottom of 2 ft. 4 in.; and it has been observed that in the two cases of the Grenelle and of the Passy wells, the deliveries have been in the direct ratios of the diameters of the borings.

Arthanitin. *Cyclamin*, a bitter non-nitrogenous matter contained in the root of *Cyclamen europæum.*

Arthritis (Gr. ἄρθρον, *a joint*). Gouty inflammation of the joints.

Arthrodia (Gr. ἀρθρωδία, *articulation*). A connection of bones in which the head of one is received into a very superficial cavity in another, so as to admit of motion in almost all directions; as in the joint between the *humerus* and *scapula*.

Arthrodieæ (Gr. ἄρθρον). A name given to those Algæ which, like *Conferva* and *Oscillatoria*, have an articulated structure.

Arthrodynia (Gr. ἄρθρον, and ὀδύνη, *pain*). Rheumatic and other painful affections of the joints.

Artichoke (Kharciof, *the Arabic name of the plant*). A thistle-like plant, called by botanists *Cynara Scolymus*, a native of the south of Europe, and now cultivated for its 'bottom,' that is, for the sake of the fleshy sweet receptacle of its flowers. The harsh hairy substance that is pulled away consists both of the hairy paleæ of the receptacle, and of the feathery pappus of the ovaries. The dried artichokes, called by the French 'culs d'artichaut,' are the receptacles deprived of the choke and the spiny hard hairs of the involucre, blanched by immersion in boiling water and dried in the sun. Jerusalem Artichokes are quite different; they are the tubers of *Helianthus tuberosus*, and derive their name, not from the Holy City, but from a corruption of the Italian *girasole*, a sunflower.

Article (Lat. articulus). In Ecclesiastical Law, the name given to the 'first plea,' that is, the charge or indictment, in criminal cases.

ARTICLE. In Grammar, a part of speech prefixed to substantives in order to render their signification more or less definite. [GRAMMAR.]

Articles of Faith are the particular points of doctrine which together make up the sum of the Christian belief. The various churches of Christendom, not being agreed upon all these points, have for the most part set forth their own expositions of the whole; and it is to these creeds, symbols, or confessions, that the term

articles is most commonly applied. The articles of the English Church are thirty-nine in number; the substance of which was first promulgated in forty-two articles by Edward VI., in 1553. Under Henry VIII. a committee had been appointed for the formation of ecclesiastical laws, which was renewed under his successor; and in 1551, 'the archbishop (Cranmer) was directed to draw up a book of articles for preserving and maintaining peace and unity of doctrine in the church, that, being finished, they might be set forth by public authority.' From this and the details that follow, it seems that Cranmer composed the articles in their original form, with the assistance of Ridley and others. A great similarity in thought and expression may be traced between many of the articles and the language of the Augsburg Confession: the XIth Article on justification) corresponds with what Cranmer had previously written on the subject in private memoranda. There has been considerable question raised as to the authorities from which the XVIIth Article (on predestination) is derived; for while some persons have interpreted expressions in it according to the Calvinistic system, others have denied the justice of such interpretation, and have undertaken to show that Cranmer must have referred in the composition of the article to the writings and sentiments of Luther and Melancthon.

On the accession of Elizabeth these articles were remodelled by Archbishop Parker, who omitted four of them, introducing four new ones, and altering seventeen. These were again revised by Convocation in 1563, some alterations made, and the number reduced to thirty-eight.

The XXXIXth was restored in a final review by Parker in 1571, and then imposed on the clergy for subscription. It is remarkable that in the manuscripts and earliest editions there is one important variation in the admission or rejection of the first clause of the XXth Article, the authority of which may be considered as virtually recognising and establishing it.

Articles of the Peace. In Law, one bound before a magistrate under a penalty, with or without sureties, to 'keep the peace' for a certain time, is said to enter into articles of the peace.

Articles of War. The code of military law embodied in the Mutiny Act, which is passed each year.

Articulated (Lat. articulus, *a joint*). Literally, connected by an articulation or moveable joint; but in Botany applied to cases where the parts of plants are so slightly connected that they finally fall asunder. Thus a leaf is said to be articulated with its stalk when the two finally fall asunder. A flower-stalk is articulated in the middle when it is contracted, and finally separates there into two parts. This separation is called disarticulation. It is a curious fact that the articulation of plants uniformly takes effect across the longitudinal or woody tissue, and never parallel with it; as in the petiole, in a stem at its nodes, in the middle of legumes and other kinds of seed vessels.

Articulates, Articulata. A term applied by Cuvier to a primary division of the animal kingdom, characterised by an external skeleton in the form of a series of rings articulated together and surrounding the body; by an internal gangliated nervous system; the ganglions being arranged symmetrically along the middle line of the body [HOMOGANGLIATA], and by having distinct respiratory organs.

Articulation. In Painting and Sculpture, this term indicates the moveable connection of the bones, in the representation of which the artist needs the greatest skill and knowledge of anatomy.

Artificer (Lat. artifex, from ars, *art*, and facio, *I make*). Lit. one who makes according to art. An artificer is one who requires intellectual refinement in the exercise of his profession, in contradistinction to an artisan, whose knowledge is limited to the general rules of his trade.

Artillery (Lat. ars, artis, used like machina, the Greek μηχανή, in the sense of an engine of war). This term originally signified all weapons of offence or defence, the machines employed in warfare, &c. Since the introduction of gunpowder, however, it has been chiefly confined to large ordnance, viz. cannon, howitzers, mortars, rockets, &c., with their carriages, ammunition, and apparatus of all kinds, and the 'personnel' appointed for their management.

The principal military engines of the Romans corresponding to our artillery were the balista and catapulta, the former of which chiefly propelled stones, and the latter arrows. These engines were extensively employed in the later periods of the Republic, and under the Empire. In the middle ages, machines for the assault and defence of towns and castles were used in great numbers; among them may be named the trebuchet or tripget, the mangona or mangonel, briccola, pierrier or petrary, &c. Some of these engines were of great power, and threw missiles of as much as 300lbs. weight. Froissart tells us that at the siege of Auberoche in 1345, the Earl of Derby, by means of one of these mangonels, threw back into the town a man who had been sent to demand terms of him.

The history of the early employment and manufacture of cannon will be found in the article CANNON.

At first, artillery was the property of the great towns and castles, for in those times kings could scarcely afford so expensive an appliance of warfare. Later only, when kings permanently retained large armies, they became possessors of artillery of their own, and had no longer to borrow from their towns. Louis XI. of France and Charles the Bold of Burgundy, in the latter half of the fifteenth century, did much towards improving artillery, and towards the close of that century the artillery of Charles VIII. was well and carefully organised. The seventeenth century was an important epoch for

this arm. Gustavus Adolphus paid much attention to its improvement and organisation, as also did Louis XIV. of France. In the following century Frederick the Great, in the Seven Years' War, introduced horse artillery able to keep pace with rapid manœuvres; and in France, in 1732, the whole system was put on a new footing, and simplified. In our own country, before the wars following the French Revolution, artillery was distributed among the infantry in the proportion of two guns to each battalion, but a new arrangement was then introduced by which guns for field purposes were united into batteries of six pieces. This much increased the power of the arm, and the whole equipment was at the same time simplified and lightened.

Artillery as it is now employed may be classed under the heads of Field Artillery, Siege Artillery, and Garrison Artillery; its equipment is a combination of men, horses, and matériel.

Field Artillery is divided into—1. Horse artillery batteries, which act and manœuvre with cavalry, the gunners all being mounted on horses or on the carriages. These batteries in our service are armed with 9-pounder Armstrong breech-loading rifled guns. A battery of horse artillery equipped for active service consists of 253 non-commissioned officers and men, 272 horses, 6 guns with limbers, and 22 other carriages. 2. Field batteries, which are armed with 12-pounder Armstrongs, and act and manœuvre with infantry. The gunners march on foot, but can be mounted upon the carriages if required. A field battery for active service consists of 236 non-commissioned officers and men, 210 horses, 6 guns with limbers, and 22 other carriages. 3. Batteries of position, armed now with 20-pounder Armstrong guns. These batteries do not manœuvre, but follow the movements of an army, ready to take up positions as required. 4. Mountain batteries, armed with 6-pounder Armstrong guns, which are light enough to be carried on mules, as are also their carriages.

Siege artillery, as its name implies, is used in the attack of fortified places, where it plays a most important part. The guns likely to be most used by us in future sieges are the Armstrong 40-pounders.

Garrison artillery is for the defence of fortresses and garrisons.

The 'personnel' for the service of siege or garrison guns is combined into batteries of 120 non-commissioned officers and men; which number allows three reliefs of ten men for each of three guns, and a few spare men for other purposes.

The regiment of artillery is divided into brigades, and these into batteries as above described. There is a colonel in command of each brigade, and four lieutenant-colonels. Each battery is under command of a captain, with a second captain and three lieutenants under him. The men are enlisted as gunners or drivers according to size.

A battery is the tactical unit of artillery, and three field guns to one thousand men is the average proportion in European armies. In France, as with us, a battery consists of six guns; in Russia, Austria, Prussia, Sweden and Belgium, of eight; with the Swiss, of four only.

For further information the reader is referred to the Emperor L. N. Bonaparte's learned *Études sur le Passé et l'Avenir de l'Artillerie*; and for a succinct account of the organisation and equipment of artillery, its application and theory, to Major Owen's *Lectures on Artillery*. [CANNON; GUNNERY; GUN; RIFLED CANNON; &c.]

Artillery Park. The place in a garrison, camp, or the rear of an army, where the artillery is placed. The term is also applied to the whole train of artillery belonging to an army in the field.

Artillery Train. The whole of the guns, carriages, artillery stores, &c., of an army in the field.

Artiodactyla (Gr. *ἄρτιος*, *even*, and *δάκτυλος*, *toe*). An order of hoofed *Mammalia*, with toes in even number, as two or four, and which have a subdivided or complex stomach, and a moderate-sized simple *cæcum*. To this order all those animals belong which are chiefly used for human food, and which have been domesticated from a period antedating the historical epoch. The following list exhibits the fossil and recent genera, the former being marked in italics. Hippopotamus, *Hexaprotodon*, *Potamohippus*, Sus, Phascochœrus, Potamochœrus, Dicotyles, *Hyops*, *Calydonius*, **Palæochœrus*, **Chœromorus*, **Entelodon*, *Elotherium*, **Hippohyus*, **Chœropotamus*, *Hyotherium*, **Bothriodon*, **Hyopotamus*, *Brachygnathus*, *Amodus*, *Archæotherium*, **Anthracotherium*, *Acotherium*, **Heterohyus*, *Protochœrus*, **Anoplotherium*, *Eurytherium*, *Chalicotherium*, *Tapinodon*, **Xiphodon*, **Dichobune*, **Aphelotherium*, **Hyægulus*, **Cainotherium*, *Adapis*, *Dichodon*, *Merycopotamus*, **Chœrotherium*, *Chœromeryx*, Camelus, *Merycotherium*, *Agriochœrus*, Auchenia, *Helladotherium*, Camelopardalis, *Sivatherium*, *Bramatherium*, Moschus, **Amphitragulus*, *Dremotherium*, **Dorcatherium*, **Pæbrotherium*, *Palæomeryx*, Cervus, *Oratherium*, Antilope, *Leptotherium*, Ovis, Capra, Bubalus, Bison, Bos. Those genera which maintained the Eocene type-dentition of forty-four teeth have an asterisk prefixed to their name.

Artocarpaceæ (Gr. *ἄρτος*, *bread*, *καρπός*, *fruit; bread-fruit tree*). A considerable division or order among urticaceous plants, which have the fruit composed of flowers combined in fleshy heads, and the stem flowing with milk, which in most cases is acrid. The Bread-fruit tree of the South Seas, and the Jackfruit, are among the most conspicuous species. With them are associated the virulent Upas tree (*Antiaris toxicaria*), and the famous Cowtree or Palo de Vaca (*Brosimum*), which yields a rich and wholesome milk. The Bread-fruit tree itself (*Artocarpus incisa*) is a small

tree with broad lobed leaves and large globular heads of fruit; the Jack (*Artocarpus integrifolia*) has oblong undivided leaves, and a larger, coarser, and oblong fruit. In all the species of *Artocarpaceæ* the flowers are unisexual.

Arts, Fine. This term is generally applied to those arts, in which the artist seeks chiefly to give pleasure by the immediate impression produced on the mind by his work. These arts are thus distinguished from arts which are designed to answer some practical purpose, and so have been termed useful. By some the term, fine arts, which is generally taken to include those which appeal to the eye and ear alike, has been limited to the arts of painting, sculpture, and architecture.

Arum. The name of this typical genus of *Araceæ* is in the opinion of some derived from aron, which is supposed to be the ancient Egyptian name of these or some allied plants. It consists of herbaceous perennials, mostly European, with fleshy tubers, some of them yielding starch in sufficient abundance to admit of a kind of arrowroot being prepared from them. The common 'lords and ladies' (*A. maculatum*) has been thus used in the Isle of Portland, the starch bearing the name of Portland Arrowroot. The family is nevertheless extremely acrid and poisonous, but in such cases as the foregoing the acrid matter is washed out.

Arundinaceous (Lat. arundo, *a reed*). Any plant having the general appearance of a reed.

Arundo (Lat. *a reed*). A genus of grasses, of tall upright habit, one of which (*A. Donax*), a South European species, is grown in gardens for the ornamental effect produced by its tall leafy stems. The common Reed (*Phragmitis communis*) was formerly included in the present genus under the name of *A. Phragmitis*.

Aruspices or **Haruspices.** Roman soothsayers, who foretold future events from the inspection of the entrails of the victims offered at the altars of the gods. Their college was not held in the same respect as that of the augurs, and did not consist, like the latter, of men of high distinction; Cicero mentions the admission of one of their order to the senate, as an indignity to that body. Like that of the augurs, their art was brought from Etruria. The latter part of the word contains the root *spac*, to see; and Donatus derives the former part from *haruga*, a victim.

Arvales Fratres (Lat.). [AMBARVALIA.]

Arvicola (Lat. arvum, *a field*, colere, *to inhabit*). A genus of rodent, or gnawing mammals, of the numerous family of the rat and mouse (*Muridæ*), distinguished by the prismatic form and fangless structure of the molar teeth, and of which the field campagnol (*Arvicola agrestis*) and the bank campagnol (*Arvicola riparia*) are indigenous species in England. These are commonly confounded with other *Muridæ*, under the name of field mice.

Arvil Supper. A feast given at funerals in the north of England.

Aryan or **Arian Languages.** The name Aryan is applied to that great family of languages which comprises the Teutonic, Celtic, Slavonic, Hellenic, Italic, Iranic, and Indic classes of dialects. Like the Semitic, these languages belong to the inflectional stage, as admitting of phonetic corruption both in the principal root and in the terminations, and are hence called organic or amalgamating languages to distinguish them from the Turanian or agglutinative languages, which allow phonetic corruption only in the secondary elements. [AGGLUTINATE LANGUAGES.] For the origin and meaning of the term *Aryan* as applied to this family of speech, see Max Müller, *Lectures on the Science of Language*, First Series, Lect. vii. Bunsen, in his great work (*Egypt's Place in Universal History*), traces the Aryans from the original Iran in the mountains of Bactria, and assigns their first emigration to some period between B.C. 10,000 and 8000. It is almost needless to remark that for a time so long anterior to contemporary history such dates must be mere matters of speculation or conjecture.

As (Lat.). A Roman weight nearly answering to one pound, being accurately equal to 10 oz. 18 dwt. $13\frac{5}{7}$ grs. troy weight. It was divided into 12 ounces (unciæ).

It was also the name of a brass coin, which originally weighed one pound, but was subsequently reduced by various degrees at different periods to half an ounce, in consequence of the gradual increase of the value of metal as compared with that of provisions and other necessaries, as civilisation advanced. Its value was a little more than three farthings of English money.

Asafœtida, or **Assafœtida.** (Lat. assus, *dried*, and fœtidus, *fetid*). A fetid gum resin obtained from the root of the *Narthex Asafœtida*, whence it exudes by incision in the form of a milky juice, which, when dried by exposure to the sun, acquires a mottled appearance and pink colour. It is a native of the south of Persia, Affghanistan, the Punjaub, &c., and is used in medicine as a stimulant and antispasmodic in hysteric and nervous disorders, and in spasmodic cough, asthma, and flatulent colic. Though *Narthex* is the genuine Asafœtida, it is probable that a similar substance may be yielded by certain species of *Ferula*.

Asagræa. A plant so named after Dr. Asa Gray, an accomplished botanist of North America; it yields the Cebadilla seeds of the druggists, from which the alkaline poison veratria, occasionally employed in medicine, is prepared. *Asagræa* is a native of the cool uplands of Mexico, and has bulbous stems, linear grass-like leaves, and racemed spikes of whitish flowers. The only species is called *A. officinalis*.

Asaphus (Gr. ἀσαφής, *obscure*). A name devised to express the obscure nature of the

genus of Trilobites, fossil Crustaceans, to which it is attached; and which is characterised by a tail-like appendage terminating the posterior extremity of the body, sometimes of a semi-circular form, sometimes in the shape of a short triangle, and by tuberculate eyes, which have a granular surface arising from the number of compartments (at least 400) on the surface of the cornea, containing each a separate spherical lens. Remains are found in the Wenlock limestone.

Asarabacca (Asarum, *a kind of plant*, and bacca, *berry*). A small stemless hardy European herbaceous plant, called *Asarum*, with round hard chocolate-coloured three-lobed flowers, belonging to the natural order *Aristolochiaceæ*. It is reputed to be a sternutatory. The French call it cabaret, the public-house plant, because, as it is said, it was formerly used as an emetic to relieve the stomachs of people who had been drinking too hard.

Asarin. A crystallisable substance, somewhat resembling camphor, extracted from the roots of the *Asarum Europæum*.

Asbestos, or **Asbestus** (Gr. ἄσβεστος, *unconsumable*). A fibrous variety of Actinolite or Tremolite, composed of easily separable filaments, with a silky lustre. The fibres are sometimes as fine as those of flax, and advantage has been taken of their incombustibility to weave them into a cloth, which, when soiled, regains its original purity on being heated to redness. The ancients are said to have wrapped the bodies of the dead in a cloth of this kind before burning, in order to keep their ashes separate from those of the funeral pile. Asbestos is found in Savoy, the Tyrol, and in large quantities in Corsica. It also occurs in Greenstone-dykes on either side of Llyn Padarn, and about Snowdon in North Wales; in almost all the Serpentine of the Lizard, and in the Greenstone and Serpentine of Clicker Tor, near Liskeard in Cornwall; Portsoy in Banffshire; Glenelg in Inverness-shire; the Shetlands; and in Ireland near Strabane, and at Bloomfield, county Wexford.

Asbolane (Gr. ἀσβόλη, *soot*). A mineralogical synonym for *Earthy Cobalt* [which see].

Asbolin (Gr. ἀσβόλη). A resinous pitchy matter obtained from wood-soot.

Ascalaphus. A Fabrician genus of insects separated from the ant-lions (*Myrmeleon*) of Linnæus, and characterised by having nearly equal palpi; maxilla ciliate; labium horny, rounded, and entire.

Ascarides (Gr. ἀσκαρίς, a term applied by Hippocrates to certain intestinal worms). In modern Zoology this name is restricted to a genus of round worms, or Calælminthans, with a trilobate or trivalvular head, and a double spiculum for the intromittent organ. Two species of this genus infest the human body; one large, found in the small intestines, called *Ascaris lumbricoides*; the other of very small size, found in the rectum, called *Ascaris vermicularis*.

Ascending Node. In Astronomy, is that point of a planet's orbit in which it crosses the ecliptic, proceeding northward. [Node.]

Ascending Signs. The signs are said to be ascending when they are eastward from the meridian, and consequently approaching the meridian through the effect of the diurnal rotation.

Ascension (Lat. ascensio). In Astronomy, is either right or oblique: the Right Ascension of a star denotes the arc of the equator intercepted between the first point of Aries and that point of the equator which comes to the meridian at the same instant with the star. The most convenient way of defining the place of a star is to refer it to the equator, and to a certain fixed point in the equator from which the degrees are begun to be reckoned. For this purpose astronomers choose the point of the equator at which the sun's path crosses it when he ascends into the northern hemisphere, which is the first point of Aries, or the vernal equinox, and reckon the degrees along the equator eastward, all round the circle. Now, to determine the place of any star, a great circle is conceived to pass through it, intersecting the equator at right angles. The distance of the star from the equator, measured on this circle, is called its declination; and the distance of the point of intersection of the equator and the circle from the vernal equinox is called the right ascension of the star. The right ascension and declination are thus the two co-ordinates by means of which the place of any star is determined. The right ascension is reckoned in time, because it is found by observing on the sidereal clock the time which elapses between the passage of the first point of Aries and that of the star over the meridian. When the first point of Aries passes the meridian the astronomical day begins; astronomers then reckon 0 hours 0 min. 0 sec. Suppose a star to come on the meridian 5 hours 35 min. 26 sec. after this; then 5 hours 35 min. 26 sec. is the star's right ascension in time, and is equivalent to an arc of the equator of 83° 51′ 30″, because an hour in time corresponds to 15° in space, and a minute or second in time to 15 minutes or seconds in space. If the clock, therefore, is regulated to keep time with the heavens, the time indicated by the clock at which any star passes the meridian is the right ascension of the star in time. The Oblique Ascension of a star is the arc of the equator intercepted between the vernal equinox and that point of the equator which comes to the horizon at the same time with the star. This varies with the latitude of the place of observation. At the equator it coincides with the right ascension. This term is now seldom used in astronomy.

Ascension. In Theology, the reception of our Saviour into glory, after His last appearance on earth: celebrated in the Christian Church on the last Thursday but one before Whit-Sunday. Rogation week, that in which the Ascension is celebrated, is so termed from the rogations (petitions or litanies) which were

used in the perambulation of the bounds of the parish, which, according to ancient usage, took place in this week.

Ascensional Difference. In Astronomy, is the difference between the oblique and the right ascension. This term is chiefly used in respect of the sun, because when the arc which it denotes is turned into time it shows the time before or after six o'clock of sunrise. The sine of the ascensional difference is equal to the tangent of the latitude multiplied into the tangent of the star's declination; hence, when the declination of a star is north, its oblique ascension is found by subtracting the ascensional difference from the right ascension, and when the declination is south, by adding the ascensional difference to the right ascension.

On account of the greater precision with which observations are made with fixed meridional instruments, all astronomical elements are now computed from observations of right ascension and declination; but in ancient times the positions of the celestial bodies were chiefly referred to the horizon, and hence the *oblique ascensions* and *ascensional differences* entered constantly into the solutions of astronomical problems.

Ascent (Lat. ascensus). In Mechanics, the motion of a body from the earth's centre. [Acceleration and Retardation.] In Geometry, the *lines of steepest ascent* on any surface cut the *lines of level* at right angles. [Slope; Level; Descent.]

Ascetics (Gr. ἀσκητικός, from ἀσκέω, *I exercise*). Persons who, in the early ages of Christianity, devoted themselves to a solitary and contemplative life, following the system of the Essenes and Therapeutæ among the Jews, and practising great austerities, with a view to mortify the flesh and withdraw the mind from worldly objects. They haunted the deserts of Egypt and Syria, and appear to have suggested the first idea of Christian monachism.

Ascians or **Ascii** (Gr. ἄσκιος, from ἀ priv., and σκιά, *shadow*). A term found in the older works on geography, and used to denote those inhabitants of the globe who at certain times of the year have no shadow. This can only happen with respect to the inhabitants of the torrid zone, who, twice a year, have the sun in the zenith.

Ascidian, Ascidia (Gr. ἀσκίδιον, dim. of ἀσκός, *a bottle* or *pouch*). A genus of heterobrachiate acephalous Mollusks, or Tunicaries, characterised by a body having the form and commonly the consistence of a tough leather pouch, attached to some foreign substance, and with two openings, one branchial, and the other anal, from which streams of water are forcibly ejected when the animal is touched or irritated.

Ascidium (Gr. ἀσκίδιον). A hollow pitcher-shaped body found upon the stems of certain plants, as *Nepenthes, Sarracenia*, &c. It usually contains water, and is sometimes clothed with reflexed hairs, which prevent the escape of insects which fall into it; its use is unknown. In *Dischidia*, it is in reality a leaf rolled up till its edges touch, when they grow together; in *Marcgraavia*, it is a bract in the same state.

Ascites (Gr. from ἀσκός, *a leathern bag* or *bottle*). Dropsy of the abdomen.

Asclepiadaceæ (Asclepias, *one of the genera*). Monopetalous Exogenous plants, with bifollicular fruit, the stamens adhering to the stigma, which is large and pentagonal, and having an acrid milk in their stems. They are exceedingly different in appearance, some being trees with showy flowers, others obscure twiners with very inconspicuous herbaceous corollas, others herbaceous plants with clusters of gaily coloured flowers, and others leafless decumbent shrubs with angular stems and brown flowers having a putrescent odour. The latter are *Stapelias*. *Hova*, with its delicate waxen flowers running with honey, is a genus of the order; and another is the curious climbing water carrier called *Dischidia*, which mounts to the tops of lofty trees with its fleshy bags filled with a constant supply of fluid. Some of the species are valuable for the toughness of the fibre extracted from their stems. The milky secretion of these plants contains caoutchouc; it is of an emetic nature, and in some cases poisonous. *Asclepias tuberosa*, the Butterfly weed of North America, is the handsomest of the hardy species.

Asclepiadine. A bitter non-azotised emetic met with in the root of *Asclepias Vince toxicum*.

Asclepion. A tasteless neutral body contained in the juice of *Asclepias syriaca*.

Ascus, pl. **Asci** (Gr. ἀσκός). Little membranous bags or bladders, in which the seed-like reproductive particles or spores of Lichens, Fungi, &c. are enclosed.

Asexual Plants. The same as Cryptogams, though modern discoveries show the application of such a name to be erroneous, sexual organs having been discovered in all the great divisions of Cryptogamous plants.

Ash (A.-Sax. æsc). The *Fraxinus* of botanists, consists of several species of hardy trees, usually valuable for their timber. The tough ash wood of carpenters is yielded by *F. excelsior*, and the sweet substance called manna by *F. Ornus*. They mostly bear flowers without petals; but the latter species having those organs developed, is called, in distinction, the Flowering Ash.

Ashlar. The name given to the dressed stones used for facing work, when it is worked in regular beds and joints.

Ashlaring. The stone used as ashlar is called ashlaring, when in thin slabs, and made to serve merely as a case to the regular body of the wall. In this case the ashlar stones require to be well bonded to the subjacent structure, and to be tied in at distances by bond courses.

Ash-Wednesday. The first day in Lent, in the Latin Church dies cinerum, *the day of ashes*, so called, because in the primitive Church

it was the custom on that day for penitents to appear in church clothed in sackcloth, upon which occasion ashes were sprinkled upon them.

Asia. A great tract of land, ranging over nearly 180 degrees of longitude, chiefly in the north temperate zone of the eastern hemisphere. It is crossed almost from east to west by a broken chain of high ground which in one part rises into the loftiest elevations of the globe, and which in various other parts rises into important mountain chains. Numerous rivers proceed from this mountain chain to the ocean. Of this great tract, which is connected with Africa only by a narrow and insignificant isthmus, the part east of Africa is called the Asiatic, and the part to the west, the European continent. There is no natural division between them, except the low chain of the Urals.

Asia presents many peculiarities of physical geography. Besides possessing the loftiest land on the globe, it has in many parts a singularly broken outline of coast, and a remarkable fringe of islands. It has few considerable lakes, but many vast plains crossed by gigantic rivers forming large river systems. Its climates are as variable as any that may be met with on the earth. It penetrates far into the arctic circle, and enters the tropics by three important peninsulas. The islands parallel to its coast and projecting from its peninsulas are not less interesting than the main land itself. We may consider separately its mountains, plains, and river systems. The adjacent islands will be mentioned under their respective names.

Mountain chains.—The middle portion of Central Asia presents four systems of mountains ranging from west to east and parallel to the greatest dimension of the whole tract of land. There are many subordinate ranges, generally parallel to the coast lines.

These four systems connect with and form parts of one principal mountain axis attaining its greatest elevation in the Himalayan chain, at a point nearly midway between the valleys of the Indus and the Bramahpootra. At this point rise the peaks of Dhawalagiri to the height of at least 28,000 ft. above the sea. To the north are ridges separated by very lofty table land, and terminating in the Altai mountains. To the east extend the mountains of China in the south, and those of Mantchou Tartary in the north, while westwards the Himalayan range is connected with the Taurus and the Caucasus by the table lands and mountains of Persia, and so passes into Europe to join the Alps. Besides the main chain there is an important east and west chain in Northern India (the Vindhya chain) and numerous series of mountains running southwards towards the volcanic islands of the Indian Archipelago. The Arabian mountains, passing away to the south-west, furnish the connecting link with the extremely lofty and recently determined snow mountains of Africa south of Abyssinia.

Not only are the separate peaks of the Himalaya of extraordinary elevation, but the mean height of the mass far exceeds that of any other mountain chain. It is variously estimated at from 12,000 to 20,000 ft., but not less than forty peaks of the chain are more lofty than Chimborazo, and a large number of them certainly exceed 25,000 ft. Throughout this district of the higher mountains the valleys are deep gorges, and the descent to the plains on the south side is extremely and unusually rapid, there being nowhere any extent of level ground.

The northern side of the Himalayas is little known and very difficult of access. The plains, however, on that side are very lofty, and the final termination in the Altai chain does not rise very high above the foot of the plains of Central Asia.

The snow line on the Himalayas is very high, and much higher generally on the north than on the south side. The passes across are few and lofty: several are far above the summit of Mont Blanc. One of them is estimated at 20,000 ft., and all are dangerous and difficult, owing to the extremely narrow width of the valleys and the suddenness with which the rise takes place from the southern side.

Many of the mountains of the northern part of the great range are volcanic; but this is not the case with any of the loftier peaks, which are either of granite, gneiss, or quartzite. The western extensions of the main chain are lost in the table lands around the great Aralo-Caspian district, and connect themselves with the Ural chain in the north as well as with the Caucasus and Taurus in the west. The table land of Arabia and its recent volcanic aspect may hereafter afford a clue to the more modern changes that have taken place in this great district of elevated land.

Plains.—Of the land north of the Himalayan mountains, as well as of that to the south and west, the greater portion is true table land, though much of it is traversed by gigantic rivers. In the west the plateau of Iran or Persia, and that of Arabia, are both remarkable for their general barrenness, in a part of the world where rain alone is almost sufficient to ensure abundant vegetation, and this character of barrenness seems to extend widely towards the east. This western plateau is estimated to occupy 1,700,000 square miles, and to have a general elevation of nearly 4,000 ft. The plains of Armenia and the great salt desert of Persia are, however, almost double that elevation.

The eastern plains of Thibet are separated from the western plains of Persia. A vast tract of very unequal elevation, but some of it of enormous height, extends in a series of steps descending towards the Arctic Ocean. Upwards of seven and a half millions of square miles of land are thus included. This tract is for the most part little known, but the northern part is traversed by the gigantic rivers Obi, Yenesei and many others. Parts of this plain are 17,000 feet above the sea. The plains of India occupy the southern part of the penin-

sula, and are terminated by the Ghâts or coast ranges of hill.

River systems.—The river systems of Asia are on the grandest scale, and divide themselves into three series; those, namely, which drain into the Arctic Sea, those which enter the Indian Ocean, and those which terminate in the Pacific. There is besides a great internal basin connected with the table-land of Central Asia, and more especially with the ARALO-CASPIAN region [which see].

Of the Asiatic rivers which empty themselves into the Arctic Sea three are of gigantic proportions, each having a direct course of about 1,500 miles, nearly doubled if the principal windings are included, and each draining an area of nearly a million square miles. There are more than six other large rivers, but of inferior importance. All these traverse vast dreary plains, the northern declivities of the table land of Asia, but the sources of their principal feeders are to be found at elevations very inconsiderable. The streams therefore have slow courses, easily interrupted, and forming marshes of variable and hardly measurable extent. These characterise a great part of Siberia. Two of the principal streams, the Lena and the Yenesei, terminate in deltas which are frozen for nine months of the year. The Yenesei in the upper part of its course expands to form the great lake of Baikal. The Obi, the most westerly and the largest stream, is one of those that has the slowest course.

The rivers emptying into the Pacific are also of the first class. The Hoang-ho and Yang-tse-kiang, each draining more than half a million of square miles, and each having a direct course of more than twelve hundred miles without including windings, rise together in Central Asia, and bring down vast quantities of mud, which they deposit near their mouths in the Yellow Sea. The Amour, with a larger drainage area, and a course only a little shorter, runs chiefly through Russian territory into the Sea of Okhotsk.

In the extent of their river basins and the length of their respective courses, the Ganges and Bramahpootra, the Irawady, the Indus, and the other streams entering the Indian Ocean, are inferior to the great rivers of Northern Asia, although from their position, and political and historical interest, they are much more important. The Ganges and Bramahpootra form a remarkable double river system, the sources of the two streams being at the two extremities of the Himalayan chain, and the waters converging in a magnificent delta at the head of the Bay of Bengal. The volume of water discharged is very large, and the thick jungle vegetation of the delta is a striking feature. The Indus and other rivers also rise in the Himalayan chain. The Euphrates and Tigris originate in the table land of Armenia. They also combine near the coast.

Several rivers not communicating with the ocean traverse parts of Central Asia: no less than six river systems here occur which have no drainage beyond the table land. The evaporation from the lakes is equal to the quantity of water entering them by the different streams. One of these rivers, entering the Sea of Aral, is not inferior to the Danube in length of course and drainage area. The Volga, entering the Caspian Sea, is a still more important stream.

Lakes.—The lakes of Asia, except the Caspian Sea, the Sea of Aral, and Lake Baikal, are of trifling importance and are little known. These three, especially the first and third, are of large dimensions and considerable interest, but they are much smaller than the lakes of North America. [ARALO-CASPIAN.] Unlike the principal lakes of the New World, they receive rivers and have no outlet. In this respect they approximate in some measure to the condition of the interior of Africa and Australia, but the physical features of these central plains are distinct. There are some salt lakes in Central Asia and some extensive volcanic districts.

Of the Asiatic Islands those of the INDIAN ARCHIPELAGO are the principal, and are separately described. The Japanese islands are very remarkable and extensive, but are even now little known. The Andaman group and other islands of the Indian Ocean are partly volcanic and partly coralline. Ceylon belongs to the Indian peninsula.

Asiarch (Gr. ἀσιάρχης). A title given to the highest religious official in that district of Asia Minor, round Ephesus, which was known especially as the Roman province of Asia. (See Acts of the Apostles, xix. 10, 22, 26, 31.) The Asiarch generally resided at Ephesus. In the same way Bythiniarchs, Galatarchs, &c., regulated religious rites and games in the Roman provinces of Bithynia, Galatia, &c.

Asilus (Lat.). A Linnæan genus of Dipterous insects, in which the mouth is furnished with a horny, projecting, straight, two-valved sucker, and gibbous at the base: antennæ filiform, approximate, of two articulations; body, oblong and conical in shape. The insects of this genus prey on other insects, especially those of the Dipterous and Lepidopterous orders.

Asmodeus. The name of an evil spirit, representing the Aêshma-daêva of the Zend-avesta. The occurrence of this name in the Book of Tobit, iii. 8, 17, shows the influence of Iranian demonology on the Hebrew mind at the time when that book was written. (Bréal, *Hercule et Cacus*, 135.)

Asp (Gr. ἀσπίς, *an asp*). A species of poisonous serpent frequently mentioned by ancient authors, some of whom describe its bite as being inevitably mortal, and say that the bitten die within three hours, and without pain, being thrown into a deep sleep; whence it was selected by Cleopatra as the instrument with which at once to terminate her existence, and bereave her conqueror of the chief feature of his triumph. There is always much difficulty in identifying the precise species mentioned in the classical writings of antiquity, from the

vague manner in which they are there spoken of. Some naturalists are of opinion that the species of hooded viper, called by the modern Arabs 'El Haje' [*Vipera* (*Naja*) *Haje*, Cuvier], is the 'Aspis' of the ancients; and as it possesses the power of distending the skin of the neck, like the Indian Cobra di Capello, it agrees with one of the characters assigned by Pliny to the Aspis—'Colla aspidum intumescere,' lib. viii. The size, however, of the Haje, which varies from three to five feet, is greater than that which is usually attributed to Cleopatra's asp.

Asparagin. A white crystallisable substance obtained from the expressed juice of asparagus. It has been proposed as a diuretic in medicine.

Asparagineæ (Gr. ἀσπάραγος). A genus of spiny Liliaceous plants, many of which are shrubs, and climb upon other plants. They all have minute scale-like leaves, small white or greenish flowers, and berried fruit; very often they produce short leafless branches, in room of leaves. *Asparagus officinalis*, one of the few species which neither climb nor bear spines, is found wild occasionally on the seashore near Weymouth. The succulent shoots which it throws up from its underground eyes are the asparagus of the market gardeners. It is not a little singular that, although this plant has been an object of careful cultivation for so many years, it should never yet have produced a well-marked permanent variety; the sorts, as they are called in the shops, are produced by casual differences of soil or cultivation, and are not distinct varieties.

Asparaginous Plants. In a strict sense this term ought to be applied only to such plants as belong to *Asparagineæ*; but in horticulture it is used to signify all those culinary vegetables the points of the tender shoots of which are eaten when they just emerge from the soil, in the same manner as those of asparagus: such, for example, as the points of the common hop, of the seakale, &c.

Asparamide. Another name for asparagin. [ASPARAGIN.]

Aspartic Acid. When asparagin is boiled with magnesia it is resolved into ammonia and a peculiar acid called as above.

Aspasiolite. A variety of Iolite occurring in six-sided and twelve-sided prisms, of a greenish-grey to a whitish colour and with a feeble lustre, at Krageroe in Norway.

Aspect. [ASTROLOGY.]

Aspergilliform (in Ecclesiastical Latin, aspergillus, *the brush with which holy water is scattered about in Roman Catholic places of worship*). Anything shaped like an aspergillus; it is chiefly used in speaking of the stigmas of grasses.

Aspergillum. A genus of tubicular Bivalves, characterised by the soldering of both valves to the inner surface of the calcareous sheath; which is dilated or club-shaped at the lower end, and perforated there by many small holes, whence it has obtained the trivial name of the 'Watering-pot Shell.' In the system of Woodward, this rare and remarkable genus ranks among the Family *Gastrochænidæ* of the Class *Acephala*.

Asperifoliæ (Lat. asper, *rough*, folium, *a leaf*). The name given by Linnæus to the plants now called Boraginaceous.

Aspermous (Gr. ἄσπερμος, from ἀ, *without*, σπέρμα, *seed*). In Botany, destitute of seed.

Aspertannic Acid. An organic acid said to exist in the *Asperula odorata* or Sweet-scented Woodruff.

Asphalt, or **Asphaltum** (Gr. ἄσφαλτος). A compact kind of Bitumen. It is black, very fusible and inflammable, burning with a smoky flame. It is found in great abundance on the surface and shores of the Dead Sea (which has been called in consequence the Asphaltic Lake), in the islands of Barbadoes and Trinidad; in a lake in Texas about a quarter of a mile in circumference, and in various other localities. The ancients employed it in some of their cements, and it was also used by the Egyptians in the process of embalming, either alone or in combination with other substances. At present its principal use is for pavements, and as a constituent of varnishes.

Asphodeleæ (Asphodelus, *the principal genus*). A subdivision of the natural order *Liliaceæ*, comprehending the Onion, the Squill, the *Ornithogalum*, *Anthericum*, *Asparagus*, and similar genera. They differ little from true *Liliaceæ*, except in the size of their flowers, which are usually smaller. [LILIACEÆ.]

Asphyxia (Gr. ἀσφυξία, from ἀ priv., and σφύξις, *pulsation*). A fainting fit: a state in which the pulse cannot be felt, and in which the powers of mind and body are suspended.

Aspidorhynchus (Gr. ἀσπίς, *a shield*, ῥύγχος, *a beak*.) The name of a fossil extinct genus of Sauroid fishes characterised by the length and bony covering of the upper jaw.

Asplenium (Gr. ἄσπληνον). The type of one of the principal minor groups into which ferns are divided by recent pteridologists, the old genus *Asplenium* being the equivalent of the modern *Asplenieæ*. They are known by their indusiate sori, in longer or shorter lines and seated laterally on the veins to which they are attached. There are, according to some authorities, about 300 species in the modern restricted genus, which excludes all those with netted venation, as well as those with double sori, either set back to back on the same vein as in *Diplazium*, or set face to face on contiguous veins as in *Scolopendrium*. The name *Asplenium*, whence comes Spleenwort, was given from some supposed virtues in affections of the spleen, possessed by species once referred to this genus, but which are now removed. Indeed the Miltwaste, or Spleenwort, which seems to have had most repute, was the plant now known as *Ceterach officinarum*.

Assadulcis, or **Asadulcis** (Lat. assus, *dried*, and dulcis, *sweet*). A gum resin, supposed to be the produce of *Thapsia garganica*,

and held in high repute among the ancients. The term has also been applied to benzoin.

Assai (Ital. *enough*). In Music, an adverb of quantity prefixed to such words as *allegro*, *adagio*, &c., signifying that the motion of the bars or measures should be kept at a mean rate of quickness or slowness, quick or slow enough, but not too much so.

Assamar. One of the constituents of burnt sugar. Toasted bread is said to owe its flavour to this substance.

Assassins. Those who attack and kill by treachery and violence persons unprepared for defence. The word is derived from a military and religious order, formed in Persia by Hassan Ben Sabah, about the middle of the eleventh century, and called Assassins from their immoderate use of Haschisch (henbane), which produced an excitement amounting to fury. So that Assassin, instead of a secret murderer, means, in fact, 'an habitual drunkard.' Hammer, in his History of the Assassins, has opened some new and striking views of the origin, proceedings, and doctrines of this sect. Their principal seat was in the mountains; and they were subject to the control of a prince, or, according to Hammer, a grand master, who possessed such an ascendency over his fanatical subjects that they paid the most implicit deference to his commands, and courted danger, and even certain death, in the execution of his orders. Nor did they stoop to humble prey; for the more lofty the object of their hatred, the more sure and deadly was their aim. In the time of the crusades they mustered to the number of 50,000, and presented a formidable obstacle to the arms of the Christians. Among the victims of their swords, at this period, may be mentioned Conrad, Marquis of Montferrat, who was murdered in the market-place of Tyre, in the year 1192. Several historians have charged upon Richard I. the instigation to this crime; but his guilt is very doubtful. (Gibbon, *Roman Empire*, ch. lix.) Long after this period the Assassins continued to levy contributions; but, after an obstinate resistance, they were at length effectually crushed by the Sultan Bibars. Scattered abroad, however, hated and despised, the order of the Assassins, like that of the Jesuits, survived long after its nominal suppression; and remnants of the Assassins still exist both in Persia and Syria, but merely as one of the many sects and heresies of Islamism, and utter strangers to the murderous tactics of their predecessors.

The numerous battles and enterprises of the Assassins, their valorous defence against the armies of the crusaders and the Sultan, and the adventurous character of their whole history, opened to Syrian writers a fertile source of romance, of which, according to Hammer, they have freely and skilfully availed themselves.

Assault (Fr., from Lat. assilio, *I leap upon*). In Fencing, a mock engagement with foils, in imitation of a real single combat.

Assault. In Law, includes a great variety of violent acts committed against the person of another, from a mere blow, or even attempt to strike, to the most serious injuries. 'Battery,' or actual beating, though generally charged as an indictment together with assault, is held to comprehend it. A 'common' assault is distinguished from an assault 'with intent' to commit murder, or any minor offence. Common assaults are punishable by summary conviction before two justices under 24 & 25 Vict. c. 100.

Assault. A term generally applied to an effort by an attacking party to carry by open force a strong position, fortified post, camp, or the breach made in a fortress.

Assay (Fr. essayer, *to try*). This term is sometimes employed as synonymous with analysis, but more generally restricted to the determination of the composition and consequent value of alloys of gold and silver. From the quantity of coin, plate, and trinkets constantly fabricated, the art of assaying is of much importance, and requires considerable practical skill in its performance. At the Mint there were originally two assay masters, the master's assayer and the king's assayer: the business of the former was to receive the gold and silver ingots brought for coinage, to cut one or more pieces from each ingot, and to make written reports of each assay. The king's assayer examined the melted bars previous to their passing into the moneyers' hands for coinage, and was responsible for their standard purity: and the money coined was not allowed to go out of the mint until pixed; that is, until it had been ascertained, by the assay of one piece taken out of each journeyweight of coin, that it was of standard purity: the king's assayer therefore was a check officer upon the melter and upon the coiner, and was responsible for the standard purity of all gold and silver coin issued from the Mint. About twelve grains of gold, and twenty grains of silver, are usually employed for the assay. In the present arrangements at the Mint, the work of the king's assayer has been transferred to out-of-doors hands, but the duties of the master's assayer are conducted, as heretofore, within the Mint.

Assembly (Fr. assemblée). In French history, the four great legislative bodies which succeeded each other during the period of the first Revolution, are usually termed, 1. The *National* or *Constituent Assembly*; commenced 17th of June, 1789, by the resolution of the deputies of the communes in the States-General, constituting themselves a national assembly, to which the deputies of the nobles and clergy afterwards adhered; termed Constituent Assembly from having framed a constitution: dissolved on the acceptance of the constitution by the King, 30th of September, 1791. 2. The *Legislative Assembly*: it commenced its sittings October 1, 1791: suspended the royal authority by its decree of the 10th of August, 1792; and was dissolved September 21, 1792. 3. The *Convention* [Convention]: it commenced its

sittings September 21, 1792, with a proclamation of the Republic: was dissolved 4 Brumaire, 4th year of the Republic (Oct. 26, 1795). 4. Two-thirds of this assembly were then included in the new body of the 'Corps Législatif,' which commenced its sittings Oct. 27, 1795, forming two councils, 1. of 500 (des Cinq-cents); 2. of the Ancients (des Anciens), 250 in number. The latter body named the Directory. This assembly subsisted until the dissolution of the Directory by Bonaparte, 19 Brum. 8th year of the Republic (Nov. 10, 1799). [DIRECTORY.] The term *Assemblée Nationale* was revived for the legislative body under the second Republic, May, 1848.

ASSEMBLY, the General, of the Kirk of Scotland, is the highest ecclesiastical court of that establishment. It meets annually in May, and sits for ten successive days, with power to appoint a commission to take cognisance of any cases undecided within that period; the commission being, in fact, a continuation of the assembly, with one additional minister named by the moderator. The assembly consists of representatives from the presbyteries, royal burghs, and universities of Scotland, and from the churches in the East Indies connected with the Kirk: in all about 380 members. The meeting of the assembly is attended by a nobleman as representative of the king, with the title of Lord High Commissioner: who, however, takes no part in the proceedings. The moderator, or president, is chosen by the assembly yearly. The General Assembly is a court of appeal from the Presbytery and Synod.

Assessment. In Law, any tax imposed on persons or property. [DAMAGES.]

Assessor. In Law, a person possessed of knowledge of the law, appointed to advise and direct the decision of the judge. In various inferior courts assessors are appointed by statute. Assessors were employed, previously to the Reform Act, to assist the returning officer in deciding on the cases submitted to his cognizance at the period of an election. By the Municipal Corporation Reform Act (5 & 6 W. IV. c. 76, s. 37) the burgesses of every borough are directed to elect two assessors, for the purpose of assisting the mayor in his duty of revising the burgess lists and presiding at the elections. And, by sec. 43, the burgesses of each ward are to elect two assessors for the purpose of assisting the alderman at the ward elections.

Assets (Fr. assez, *enough*). In Law, are the fund out of which a deceased person's debts are to be paid. Assets by descent are liable to those debts only which are secured by specialty, as bond or covenant binding the party's heirs; but assets in the hand of executors or administrators are liable to all debts.

Assiento Treaties (Span. *agreement*). In History, the contracts entered into by Spain with several European nations (first Portugal, then France, and after the Peace of Utrecht in 1713, England), to supply her South American colonies with negro slaves from Africa, were so termed.

Assignats. Paper-money issued by the French Government at various periods during the Revolution, based on the security of the unsold lands of the clergy, emigrated nobles, &c., which had become forfeit to the nation.

Assignment. In Law, is the total alienation of a chattel interest: which, by the third section of the Statute of Frauds, must be, if of a term of years in land, by writing and signature. *Assignee* is the party to whom an assignment is made.

Assimilation (Lat. assimilatio). The act by which organised bodies incorporate foreign molecules and convert them into their own proper substance.

Assize (Nor. Fr. assise). 1. In a sense now obsolete, an ordinance or constitution of the sovereign: thus, the code of feudal law framed for the kingdom of Jerusalem under the Crusaders is termed the Assises de Jérusalem. 2. The ordinances regulating the price of bread and other necessaries were also called Assizes. 3. The peculiar jury by which a writ of right was tried, was termed the Grand Assize. 4. In the only sense in which the word is now an existing law term, the assize signifies the periodical session held by the judges of the superior courts in the counties of England, for the purpose of trying issues at nisi prius and delivering the gaols. [COURTS, SUPERIOR.]

ASSIZE. In Scotch Law, a term synonymous with the English jury—the assize consisting of fifteen men.

Association. In Psychology, a name given to that property of our minds, by which any object or state of consciousness (whether image, thought, or emotion) has a tendency to recal other states or objects of consciousness with which it has been previously in some way connected. The conditions under which this tendency exists were first stated by Aristotle, in his *Treatise on Memory and Recollection*. According to him they are threefold, consisting of Resemblance, Contrast, and Contiguity. If by the last word we understand connection in space and time, and that of cause and effect, this division is the same with that given by Hume, and adopted by modern philosophers. The principle of association has been applied by Hartley, Sir J. Mackintosh, Bain, and other writers on ethics, to explain the origin of our more complex emotions, and in particular of our moral sentiments.

Assonance (Lat. assono). In Rhetoric and Poetical Composition, a jingle or imperfect rhyme, formed by separate words, or members of a sentence.

Assumpsit (Lat.). In Law, is an action of an anomalous character, having the form of tort and the substance of contract. It is, properly, a claim of damages sustained through the breach of a simple contract (i.e. a promise not under seal), and alleges that the defendant *assumpsit*, i.e. promised, or undertook to per-

form the acts specified. It has become the most ordinary remedy, not only where unliquidated damages, but also where debts are sued for; the law implying a promise to pay or do whatever the defendant is legally liable to pay or do.

Assumption (Lat. assumptio). A festival of the Romish Church, kept on August 15, in celebration of the alleged miraculous ascent of the Virgin into heaven.

Assumptive Arms. In Heraldry, such as may be assumed with the approbation of the sovereign, or by a grant from the proper officers of arms: also, in another sense, armorial bearings improperly assumed.

Assurance (from Low Lat. assecuro, *I guarantee*). A contract for the payment of a certain sum on the occurrence of a certain event. The term assurance is generally confined to those contracts under which a certain sum is to be paid on the death of an individual or individuals now living; while insurance is applied to those which provide for the payment of a sum on the occurrence of events not depending on the duration of human life, and which may never happen, such as the loss of ships at sea, the destruction of houses by fire, &c.

Assurances on Lives are contracts which stipulate for the payment of a certain sum of money on the death of one or more individuals, in consideration of an immediate payment, or, more frequently, of an annuity or annual contribution, to be continued during the existence of the lives assured. Contracts of this kind are of immense importance to society. Every man whose income depends on his own life or exertions, and on whom others are dependent for support, must be sensible of the advantages of arrangements by means of which, at a small sacrifice of immediate comfort, he is enabled effectually to provide against the casualties of life. They are of a totally different nature from gambling. Though nothing can be more uncertain than the continuance of an individual life, yet nothing is more invariable than the duration of life in the mass; consequently, the exact value of life assurances can be calculated without any uncertainty whatever, and a man, by effecting an assurance, secures to his representatives, against the risk of accident, the advantages they would have from his enjoying his exact proportion of the average duration of life. Such transactions provide against destitution, and tend directly to the accumulation of capital; they will, therefore, be encouraged and protected in all well-governed communities.

Method of computing the Value of Assurances.—The value of assurances on lives is computed in nearly the same manner as those of annuities, the principles being the same in both cases. A table of mortality must first be selected, from which we deduce the probabilities of living over the different years of life. Having obtained these, and assumed a rate of interest, we proceed as follows: let the probabilities that an individual of a given age will live over

1, 2, 3, 4, 5, &c. years

be p_1, p_2, p_3, p_4, p_5, &c. respectively;

also, let r be the rate of interest, and $v = \frac{1}{1+r}$ and suppose that the sum assured is to be paid at the end of the year in which the life fails. Now, the value of 1*l.* to be received at the end of the first year is v, but it will not be received if the life continues to the end of the year; and, as the probability that the individual will live over the year is p_1, the probability that he will not live over it is $1-p_1$, therefore the value of 1*l.* to be received at the end of the year, subject to the contingency of the life failing in the first year, is $(1-p_1)\,v$. The probability that the life will continue to the end of the second year is p_2, and that it will continue one year only, p_1, therefore p_1-p_2 is the chance it will drop in the second year; and the value of 1*l.* to be received at the end of the second year is v^2, therefore the present value of 1*l.* to be received if the life fails in the second year is $(p_1-p_2)\,v^2$. In like manner, the probability that the life will fail in the third year is p_2-p_3; and the value of 1*l.* to be received at the end of three years is v^3, therefore the present value of 1*l.* to be received at the end of three years, if the given life fails in the third year, is $(p_2-p_3)\,v^3$. The same process is continued from year to year, till the probability of living over a year becomes nothing. Now, the whole value of the assurance is manifestly equal to the sum of all its partial values for the different years; therefore, denoting the value by I, we get

$$I = (1-p_1)\,v + (p_1-p_2)\,v^2 + (p_2-p_3)\,v^3 + \&c.$$

or, separating this into two series,

$$I = v\,(1 + p_1v + p_2v^2 + p_3v^3 + \&c.)$$
$$-(p_1v + p_2v^2 + p_3v^3 + \&c.)$$

But it is shown in the article Annuity that the series $p_1\,v + p_2v^2 + p_3v^3 + \&c.$ denotes the value of an annuity of 1*l.* on a life, the probabilities of the continuance of which are represented as above; therefore, calling this annuity A, we have $I = v\,(1 + A) - A$.

Since $v = \frac{1}{1+r}$, this formula becomes by substitution $I = \frac{1}{1+r}(1 - rA)$.

The sum now found is what ought to be paid down, in order to receive 1*l.* on the failure of the given life; but by far the most usual practice is to pay for the assurance by means of an annual premium, the first payment being immediate, and the others at the end of each successive year. Let π be the annual premium; then the value of all the premiums after the first is obviously the same thing as the value of an annuity of the same amount, and is, consequently, equal to π A. Hence, the value of all the premiums is $\pi + \pi$ A, or $\pi(1 + A)$, which is necessarily equivalent to the assurance. We have therefore the equation $\pi\,(1 + A) = v\,(1 + A) - A$, whence $\pi = v - \frac{A}{1+A}$.

This formula is very easily computed when we are in possession of a table of annuities, and it shows at once the annual sum which an individual of any age ought to pay, in order to secure to his representatives 1*l.* (and, consequently, any other sum) at his death.

Temporary Assurances.—The values of temporary assurances, or engagements to pay a certain sum in case a given individual dies within a given number of years, are easily found from those on the whole of life. For example, let it be required to find what sum ought to be paid for 1*l.*, to be received if an individual now aged 40 shall die within seven years. Let I be the value of 1*l.* to be paid on the death of a person aged 40, and I_7 the present value of the same sum, to be paid on the death of a person aged 47. Seven years after this the value of an assurance of 1*l.* on the death of the person now aged 40 will be I_7; but the present value of 1*l.*, to be received certainly at the end of seven years is v^7, and the probability that the life will continue seven years is p_7; therefore the present value of I_7, on the contingency that the life will not fail within seven years, is $p_7 v^7 I_7$; subtracting this from I, the value of 1*l.* to be received certainly at his death, there remains $I - p_7 v^7 I_7$, to denote the value of the temporary assurance. This may be expressed by the following rule. Multiply the assurance on a life seven years older than the given life by the present value of 1*l.*, payable seven years hence, and also by the probability that the given life will survive seven years; subtract the product from the assurance on the given life, and the remainder is the value of a temporary assurance for seven years in a single payment.

In order to find the equivalent annual payment, it must be recollected that the first payment is made immediately, and that seven payments are to be made in all; consequently, all the payments after the first are equal to a temporary annuity of the same amount for six years, or one year less than the given term; consequently, if π represent the annual premium, and A′, a temporary annuity of 1*l.* for one year less than the given term, the value of all the premiums to be received is $\pi + \pi A'$ or $\pi (1 + A')$, which by hypothesis is equal to the assurance; consequently, to find the annual premium, we have to divide the value of the temporary assurance in a single payment by $1 + A'$.

In the same manner, the value of an assurance on any number of joint lives is found: it is only necessary to substitute for A in the above formulas, the value of an annuity on the joint lives. Thus, let M be the value of an annuity, to continue while A and B both live, then $v(1 + M) - M$ is the value of an assurance to be paid at the end of the year in which the first of the two lives shall fail, and the equivalent annual payment is $v - \frac{M}{1 + M}$.

A very important class of assurances comprehends those in which the contract is to pay a sum on the death of one party, provided that another party shall be then alive. The computation of the values of such contracts is somewhat more intricate, and cannot be explained without entering into details respecting the manner of combining the probabilities of life, which our limits will not permit.

For assurances on ships and goods, see INSURANCE.

Astacus (Lat. *a lobster*). The name of a Fabrician genus of insects, and now the type of a family (*Astacidæ*) of Decapod, Macrourous, or long-tailed Crustaceans; including the lobsters (*Astacus* Leach), the crawfish (*Potamobius* Leach), and the cray-fish or spiny lobsters (*Palinurius* Leach). The distinguishing character is derived from the antennæ, the two pairs of which are inserted in the same horizontal line; the mesial ones having moderate or long footstalks, terminated by two filaments; the outer ones naked, or furnished with a scale which never entirely conceals the base.

Astarte. In Mythology, a Phœnician goddess called in the Scripture Ashtaroth. This goddess is probably identical with the Greek Aphrodite, whose connection with Adonis has a distinct reference to the mythology of Syria.

Astatic Needle. A term applied to the magnetic needle when it is withdrawn from the action of the earth's magnetism, and has no longer the *statical* position in which it is in equilibrio with the influence of this force. A needle is rendered astatic by placing the axis about which it is moveable in the direction in which terrestrial magnetism acts, because it cannot then receive any motion from this force, and will rest in any position. This effect is more usually produced by neutralising the action of the earth by means of an equal and opposite magnetic action; that is, by placing the needle vertically above or below a second magnetic needle the north pole of which is in juxtaposition with the south pole of the first needle. (Brewster, *Treatise on Magnetism.*)

Asteraceæ, so called after *Aster*, one of the most familiar genera, is a name proposed by Lindley for the great family of *Compositæ*.

Asteria. The name used by Pliny to denote the asteriated varieties of Sapphire, or those which display diverging rays of light. [STAR-STONE.]

Asterisk (Gr. ἀστερίσκος). In Diplomatics, a sign in the figure of a star, frequently met with in ancient Latin manuscripts, and seeming to serve various purposes; sometimes to denote an omission, sometimes an addition, sometimes a passage which appeared remarkable on any account to the copyist.

Asterism (Gr. ἀστήρ). In Astronomy, denotes a collection of stars. It was formerly used in the same sense as constellation, but is now generally appropriated to any small cluster of stars, whether forming part of a particular constellation, or otherwise.

Asteroids (Gr. ἀστεροειδής). A term frequently used by writers on astronomy, to designate the group of small or telescopic planets,

which revolve between the orbits of Mars and Jupiter.

Asthenic (Gr. ἀσθενικός, from ἀ priv., and σθένος, *strength*). Asthenic diseases are those which are prominently marked by great and direct debility.

Asthma (Gr.). A disease, the leading symptoms of which are difficulty of breathing, coming on at intervals, accompanied with cough, and more or less expectoration. The fit most frequently occurs in the night during the first sleep, suddenly awaking the patient, and lasting for three or four hours or more. It is a terrible, but in itself rarely a fatal, disease, though it often lays the foundation of organic mischief. Its proximate cause has not been very clearly ascertained.

Astigmatism (Gr. ἀ priv., στίγμα, *a mark*). In Optics, the name given to a peculiar defect in the eye, which consists in its refracting the rays of light differently in different planes. The defect may be detected by looking at a small pin-hole in a card, held up against the sky or any bright object, and moved to different distances from the eye. In the case of ordinary eyes the image of the hole remains circular at all distances, but to an eye having the peculiar defect in question the image of the hole, as the card is moved away from the eye, becomes elongated in a particular direction, and at a certain distance passes into a straight line. On moving the card still farther from the eye it becomes elongated in a direction perpendicular to the former, and again at a certain distance (the second limit of distinct vision) it passes into a straight line. This imperfection may be corrected by means of a cylindrical, or spherico-cylindrical, lens, the distances of the card from the eye when the two focal lines are formed giving the means of calculating the required curvature of the cylindrical surface. (See *Transactions of the Cambridge Philosophical Society for* 1829; *Reports of the British Association for* 1849.)

Astomous (Gr. ἄστομος, from ἀ priv., and στόμα, *a mouth*). A term applied to certain mosses whose theca has no aperture.

Astræa (Lat.). One of the recently discovered small planets circulating between the orbits of Mars and Jupiter. Astræa was discovered on December 8, 1845, by Hencke of Driessen, in Prussia, who had for several years previously been engaged in astronomical observations directed to the discovery of such a body. The announcement of his success excited great interest among astronomers, no other addition having been made to the planetary system since the discovery of Vesta by Olbers in 1807; but nine others belonging to the same group have since been added to the number. Astræa appears as a small star of the ninth magnitude. Its mean distance from the sun is 2·577 times that of the earth, and it completes its revolution in 1,511·095 mean solar days. Unlike the four others previously discovered in the same region, the inclination of its orbit was found to be only 5° 19′ 22·7″, which is less than the inclination of Mercury, and consequently the term *ultra-zodiacal* is no longer applicable to the whole group. This distinction also belongs to three of the others since detected, viz. Flora, Iris, and Metis. Hebe, also discovered by Hencke, has an inclination of nearly 15°. [Planet.] See the list of recently discovered planets in Astronomy.

Astræa. A genus of Anthozoa; the polypary or calcareous skeleton of which is characterised by sessile, star-shaped lamellate cells, crowded upon the upper surface. The species are divided into rayed Astrææ (*Ast. radiatæ*), with the stars separated from the base; and toothed Astrææ (*Ast. denticulatæ*), with the stars contiguous.

Astragal (Gr. ἀστράγαλος). In Architecture, a convex moulding which was originally introduced at the base of the capital of the Ionic order, and has since been applied in other positions. It is usually accompanied by some small fillets, and is in some cases ornamented, as in the arch of the Goldsmiths at Rome, where it is carved with a series of leaves and reeds bound together, and on the base of Trajan's column; sometimes it is ornamented with a bead and reel, as in the majority of examples which occur in Grecian and Roman architecture.

Astragalus (Gr. ἀστράγαλος). The ancle bone. The ancients used the corresponding bones of animals as substitutes for dice.

Astragalus. In Botany, a rather extensive family of herbaceous Leguminous plants, including a few shrubby species The most interesting are those which yield the gum-like substance called *tragacanth*, which is the produce of several dwarf spiny shrubs, e. g. *A. gummifer*, *strobiliferus*, and *verus*, growing in Kurdistan, Persia, Asia Minor, &c. The gummy matter exudes from their stems.

Astrakanite. A hydrous sulphate of magnesia occurring in imperfect prismatic crystals, in the salt lakes of Astrakan, east of the mouth of the Volga.

Astrolabe (Gr. ἀστρόλαβος). A circular instrument used for taking or observing the stars. The ancient astrolabe consisted of two or more circles, having a common centre, and so inclined to each other as to enable the astronomer to observe in the planes of different circles of the sphere at the same time. For example, if the circles were at right angles, the instrument would give both longitude and latitude, or the right ascension and declination of a star. The equatorial, the altitude and azimuth instrument, and the theodolite, are instruments which answer the same purpose as the ancient astrolabe. Ptolemy changed the form of the ancient instrument, and reduced it to a plane surface, to which he gave the name of planisphere; and from this circumstance the term astrolabe has been used in modern times to denote a planisphere, or stereographic projection of the sphere on the plane of one of its great circles.

Astrology (Gr. ἀστρολογία). According

to its derivation, this term should signify the science or knowledge of the stars. Originally, the terms astrology and astronomy were used indifferently in the same sense; but for a long time the former has been employed to denote the vain and superstitious study of predictions and horoscopes; while the latter has been reserved to denote the true science of the celestial motions. According to Lalande, this distinction began to be observed in the time of Clement of Alexandria, that is, in the second century. Astrology is generally coupled with the epithet judicial, from the judgments drawn from it relative to future events.

Judicial astrology is supposed to have had its origin in Chaldea, whence it passed into Egypt, Greece, and Italy. The desire of penetrating into futurity is so congenial to the human mind, that this pretended science has found favour in all ages and countries; and it is a remarkable fact, that astronomy, which demonstrates the frivolity and absurdity of its predictions, was long indebted to it for the principal part of its own progress. Kepler, in the preface to the Rudolphine Tables, observes, that astrology, though a fool, was the daughter of a wise mother, to whose support and life the foolish daughter was indispensable. At the present day it is only among the most ignorant vulgar, or the unenlightened tribes of Asia and Africa, that astrology is held in esteem; but the triumph of sound science and the spirit of philosophy has been slow and difficult. So late as the year 1705, the conductor of *La Connaissance des Tems* thought it necessary to apologise for the absence of all predictions in that astronomical work, by stating, that the Academy had never recognised the solidity of the rules which were given by the ancients for discovering the future by the configurations of the stars; and, what is still more surprising, the first lunar tables calculated according to the Newtonian theory were intended to be subservient to the calculation of nativities.

Astrological predictions are founded on the positions or aspects which the sun, moon, and planets have relatively to each other at the moment of birth, or some other critical period of a person's life, and on certain arbitrary influences supposed to belong to each of those bodies. For the purpose of facilitating the determination of the aspects, the whole heaven, visible and invisible, is divided into twelve equal parts by the horizon, the meridian, and four other circles passing through the north and south points of the horizon, and the points of the equator (or rather the prime vertical, or sometimes the ecliptic, for the practice was not uniform), which are at the distance of 30 and 60 degrees from the meridian. These equal spaces are called the twelve houses of the heavens, and the circles by which they are circumscribed are called circles of position. The circles of position are supposed to remain fixed, so that a celestial body is carried through each of the twelve houses in the course of a day by the diurnal rotation. The first house is contained between the eastern horizon and the next circle of position, going to the eastward; consequently the seventh will commence with the western horizon, and the tenth with the meridian or culminating point of the ecliptic. The beginning of the first house, or the point of the ecliptic just rising, is called the horoscope. The first house is the house of life; the second, of riches; the third, of brothers; the fourth, of parents; the fifth, of children; the sixth, of health; the seventh, of marriage; the eighth, of death; the ninth, of religion; the tenth, of dignities; the eleventh, of friends; and the twelfth, of enemies. Each of the houses has one of the heavenly bodies as its peculiar lord. They have also different powers, the strongest of all being the first, and the next in power the tenth; so that if two planets are equally powerful, cæteris paribus, that will prevail which is in the stronger house.

Having made the preliminary arrangement of the heavens, the next object is to consider the aspects or configurations of the influential bodies. Aspect, as defined by Kepler, is the angle formed by the rays proceeding from two planets, and meeting at the earth, and which have the property of producing some natural influence. The ancients reckoned five aspects, namely, the conjunction denoted by the character ☌, the opposition by ☍, the trine by △, the quadrile by □, and the sextile by ⚹. These names and characters, besides several others added in more recent times, are retained in our almanacks to the present day. In the aspect of conjunction the angle made by the two planets is 0; in the opposition it is 180°. The trine is the third part of a circle, or 120°; the quadrile is 90°, and the sextile 60°. With regard to the influences of the aspects, they are benignant, malignant, or indifferent. The quadrile and opposition are considered as malignant or adverse; the trine and the sextile as benignant or propitious; and the conjunction an indifferent aspect.

It now remains only to ascribe certain influences to each of the planets, and to suppose all animals, plants, countries, &c. subject to their control, in order to obtain an idea of the nature of the astrological art. The influences ascribed to the planets were of course as arbitrary as those ascribed to the aspects. Saturn being at the greatest distance from the sun was supposed to be of a cold nature; Jupiter, Venus, and the Moon, temperate and benignant. Saturn and Mars were the most dangerous. The Sun and Mercury participated in the properties of the one and the other, according to circumstances. But these influences were exerted in an infinite number of ways, according to the houses which the planets happened for the time to occupy.

It would be superfluous at the present day to adduce any serious argument against a system of imaginary influences and arbitrary rules, having no other foundation than the ignorance and superstition of mankind, and contradicted

by every result of true science, and every dictate of common sense. The celestial bodies pursue their courses in obedience to unalterable laws; and the legitimate business of the philosopher is to discover those laws, to trace out their consequences, and to apply the results of his discoveries to the well-being of humanity.

Astrometer (Gr. ἄστρον, *a star*; μέτρον, *measure*). The name given by Sir John Herschel to an instrument invented and employed by him for comparing the intensities of light of the stars one with another by the intervention of the moon, or the planet Jupiter, or some other *natural* standard, no invariable standard of artificial light having yet been discovered. It is necessary that the intermediate standard of comparison be brighter than any of the stars to be compared, so as to allow of being equalised with them by a reduction of its light optically effected, and at the same time either invariable, or at least variable in such a manner that its changes can be calculated and reduced to numerical estimation. Jupiter being brighter than any of the stars, subject to no phases, and variable in its light only by the variation of its distance from the sun, may be considered as best fulfilling all the conditions. 'The process,' says Sir John, 'consists in deflecting the light of the moon by total internal reflexion at the base of a prism, so as to emerge in a direction exactly coincident with that of the undeflected light of one of the stars to be compared. It is then received upon a lens of short focus, by which the image of the moon is formed, which, viewed at a considerable distance by an observer placed in or near the axis of the lens, will appear to him as a star. This artificial star is then to be approached to or removed from the eye until its light is judged to be exactly equal to that of the real star, which, lying in nearly the same direction from the observer, will be seen side by side with the artificial one by the same eye, or with both eyes at once, without the aid of a telescope, in the ordinary mode of natural vision. The distance of the eye from the focus of the lens being then measured, the prism and lens are to be placed so as to form another similar artificial star in a direction nearly coincident with that of the other star under comparison; and another equalisation being made and distance measured, it is obvious that the intensities of the lights of the two stars, or at least their effects on the retina under the circumstances of comparison, will be to each other in the inverse ratio of the distances so measured respectively.' (*Results of Astronomical Observations*, &c., p. 353; also *Outlines of Astronomy*.)

It may be noticed that the name *Astrometer* was given by Bouguer to the Heliometer, or object-glass micrometer. It was also given by Jeaurat to an instrument for finding the rising and setting of the stars and their position, which he has described in the *Memoirs* of the Academy of Sciences of Paris. An improved instrument for the same purpose is described in the *Edinburgh Encyclopædia*, art. 'Science.'

Astronomy (Gr. ἀστρονομία). The science which treats of the motions, distances, arrangement, and magnitudes of the celestial bodies; of their constitution and physical condition, and, in general, of whatever can be known respecting them.

There is no branch of human knowledge of which the results appear at first sight more at variance with the impressions of our senses. The first aspect of the heavens leads us almost irresistibly to imagine ourselves placed in the centre of a starry sphere; which, in its diurnal revolution, carries along with it all the heavenly bodies. But the changes of relative position which some of the most remarkable among them continually undergo, soon make it evident that they do not all belong to the same sphere. Further observation and reflection lead us to conclude that the apparent daily revolution of the firmament is merely an illusion occasioned by the diurnal rotation of our own earth, which, instead of remaining fixed at the centre, is carried forward about the sun with a velocity of about 10 miles in a second of time, or four times that of a cannon-ball when it leaves the mouth of a cannon. The sun, which appears to be of very moderate dimensions, is a body whose volume is 1,384,470 times greater than that of the earth, and distant from it about 93,000,000 of miles. The stars, which even in the best telescope appear only as luminous points, are bodies of the same nature as the sun; many of them, probably, far surpassing it in magnitude.

Different Classes of Heavenly Bodies.—By far the greater part of the celestial bodies appear to be fixed in the firmament, and to preserve invariably the same relative positions. These are the *fixed stars*. A second class comprehends a small number which are continually shifting their positions among the stars, and are perceived to accomplish a complete revolution of the sphere in stated intervals of time. Hence they were called *Planets*, that is, *wandering stars*, from the Greek πλανήτης, *a wanderer*. They describe orbits, very nearly circular, about the sun. Some of them are accompanied by smaller bodies revolving round them (as the moon revolves round the earth), called *Satellites*, or attendants. A third class comprehends bodies differing greatly from those now mentioned, and sometimes exhibiting very extraordinary appearances. These are the *Comets*. Like the planets they are obedient to the attractive force of the sun; but the orbits which they describe are exceedingly elongated, and they are only visible to us when they are near the sun. Hence they appear at distant or uncertain intervals, and only for a short time; and consequently their physical nature is very imperfectly known. The sun, planets, satellites, and comets form a system of which all the members are connected with and act upon one another in obedience to the law of universal gravitation. [See PLANETS,

SATELLITES, SUN, and the other terms, in their respective places.]

Divisions of Astronomy.—The first object of the astronomer is to ascertain, with all possible precision, the apparent places of the stars, or their projections on the sphere, in order to obtain an accurate knowledge of their apparent motions and periods. But it is not enough to have ascertained their positions and motions; the results of observations made at different places and distant times must be compared, in order that we may be enabled to distinguish the movements which are real from those which are only apparent, and depend on our own position with regard to objects observed. And when the real paths described by the different bodies have thus been determined, we are next led to investigate the causes of the phenomena, and the expressions of the mechanical forces necessary to produce them. Hence, the science of astronomy may be divided into *practical*, *rational*, and *physical*: the first embracing all that is necessary for determining the apparent motions; the second being devoted to the real motions; and the third to the physical causes by which the different motions are regulated and perpetuated.

Practical Astronomy.—In order to determine the positions and motions of the celestial bodies, it is necessary to have the means of measuring time and space with the utmost precision. But neither time nor space can be measured without the aid of very refined instruments and contrivances. Hence, the theory of instruments, the method of using them, and the determination of the different corrections that must be applied in order to free the observed positions from the various instrumental and physical errors by which they are affected, belong to this division of the science. A complete knowledge of the sphere and its various circles, as also of the methods of spherical trigonometry, is requisite to the practical astronomer. Observation gives him the place of a star only with reference to his own zenith, or horizon, or to another star whose place is already determined. But their positions must be reduced; that is, referred to invariable planes or circles, in order that the observations made in different places may be capable of comparison with one another. Without such reductions, the observations are of no use.

Rational Astronomy. — This division includes the determination of the real orbits, and the laws of motion which the different bodies observe, and the construction of hypotheses by the aid of which we may calculate the positions in advance. In the infancy of astronomy, and before observations became very numerous, or were made with precision, various hypotheses were invented to explain the apparent motions. Thus Ptolemy explained the inequalities of the planetary motions, by supposing each of the planets to describe a circle about a centre moving uniformly round the earth in the circumference of another circle. Tycho Brahe supposed the planets to revolve in circular orbits about the sun, and the sun, accompanied by the planets, to revolve round the earth. Copernicus supposed the earth, as well as all the other planets, to revolve in circular orbits around the sun. All these hypotheses served to explain the phenomena that were known at the time they were respectively invented; and have been successively exploded by more accurate observations, which have proved that the planetary orbits are not circles but ellipses, having the sun in the focus which is common to all of them.

Physical Astronomy. — By this term is generally understood the application of mathematical science to the investigation of the laws by which the motions of the celestial bodies are regulated, the nature of the forces by which their motions are maintained, and the effects of their action on one another. By comparing the momentary deflection of the moon's orbit from a straight line with the effects of terrestrial gravity, as manifested in the descent of falling bodies near the surface of the earth, Newton found that both the phenomena were produced by one and the same cause, and that the moon is retained in her orbit by the attraction of the earth. Subsequent investigations, founded on the general laws of the planetary motions, discovered by Kepler, led him to the conclusion, that a force of the same nature extends through the universe; and that all bodies in the heavens and on the earth gravitate towards each other with forces directly as their quantities of matter and inversely as the squares of their distances. By this single principle he explained the elliptic motions of all the planets and satellites, and the facts which relate to their figures, rotation, and the position of their axes. The calculation of the disturbing forces, or of the effects produced by the mutual attractions of all the bodies in the solar system, forms the most difficult and the most important problem ever submitted to mathematical analysis.

The state of perfection to which astronomy is now brought, may be regarded as the greatest triumph of human exertion and reason. The motions of the moon and the planets are known with the utmost accuracy; and the tables have all the precision which the navigator or practical astronomer can desire. Our knowledge of the planetary system is tolerably complete. That of the sidereal heavens must always be limited by the optical powers of the human eye and the telescope. In this department of astronomy a boundless field has of late years been thrown open for future research and speculation. Stars are observed revolving about one another in elliptic orbits. Are they then connected with each other by forces of the same nature, and observing the same laws, as solar attraction? The periodic times, and consequently the mean distances of one or two comets, are observed to be diminished. Are we then to infer that the regions of space are filled with matter of sufficient density to resist

the motions of comets? Are the comets themselves permanent bodies; or are they merely formed by the occasional collapse, as it were, of nebulous matter, and again dissipated after a few revolutions? The resistance of the ether, the nature of comets, the constitution of the nebulæ, the laws which regulate the formation and motions of sidereal systems: such are the questions (questions remote indeed from any practical application to the affairs of mankind) which astronomers now aspire to solve.

Among the recent discoveries in astronomy, the most prominent, and in some respects the most remarkable ever made in the science, is that of the new planet, to which the name of Neptune has been given, beyond the orbit of Uranus. In all previous instances of the discovery of a new planet, the discovery was accidental, in so far as the existence of the body was not foreknown, or even suspected, until its true nature became revealed by the observation of its relative motion. In the present case, not only had the existence of the planet been made known through the effects of its attraction, but the precise spot which it occupied in the heavens had been indicated by the results of a profound theoretical investigation, and the planet was immediately recognised on directing a telescope upon the spot so indicated.

By a singular coincidence, though not without example in the history of discovery, the problem was undertaken about the same time by two distinguished mathematicians, Mr. Adams in England, and M. Leverrier in France, neither having the slightest knowledge of the attempt of the other; and both arrived at a correct conclusion. Mr. Adams's results, however, though communicated to two or three astronomers, were not published or generally known until some time after the actual discovery of the planet, and, as it happened, did not contribute in any way to that discovery. Those of M. Leverrier were given to the Academy of Sciences at Paris, and published in the *Comptes Rendus*; and by their means the planet was found by Dr. Galle, of Berlin, on the very day on which his attention was directed to them, within less than a degree of its predicted place. This memorable discovery took place on September 23, 1846, and was hailed by every astronomer of Europe as the most signal triumph of theory which had ever been achieved.

Neptune is attended by at least one satellite, probably two, and is suspected to resemble Saturn, in having also a ring. Its position in the ecliptic, since the date of its discovery, has been unfavourable to its being distinctly seen.

The next most remarkable feature in the recent progress of astronomy is the discovery of a large number of new planets belonging to the group which circulate between the orbits of Mars and Jupiter. Their names, with those of their discoverers, and the dates of their respective discoveries, are as follow:—

Name	Date of Discovery	Discoverer
Flora	1847, October 18	Hind.
Melpomene	1852, June 24	Hind.
Victoria	1850, September 13	Hind.
Euterpe	1853, November 8	Hind.
Vesta	1807, March 29	Olbers.
Iris	1847, August 13	Hind.
Metis	1848, April 25	Graham.
Urania	1854, July 22	Hind.
Phocea	1853, April 6	Chacornac.
Massilia	1852, September 19	De Gasparis.
Hebe	1847, July 1	Hencke.
Lutetia	1852, November 15	Goldschmidt.
Fortuna	1852, August 22	Hind.
Parthenope	1850, May 11	De Gasparis.
Thetis	1852, April 17	Luther.
Fides	1855, October 5	Luther.
Amphitrite	1854, March 1	Marth.
Astræa	1845, December 8	Hencke.
Pomona	1854, October 26	Goldschmidt.
Egeria	1850, November 2	De Gasparis.
Irene	1851, May 19	Hind.
Thalia	1852, December 15	Hind.
Eunomia	1851, July 29	De Gasparis.
Proserpine	1853, May 5	Luther.
Circe	1855, April 6	Chacornac.
Juno	1804, September 1	Harding.
Leda	1856, January 12	Chacornac.
Ceres	1801, January 1	Piazzi.
Pallas	1802, March 28	Olbers.
Atalanta	1855, October 5	Goldschmidt.
Bellona	1854, March 1	Luther.
Polyhymnia	1854, October 28	Chacornac.
Leucothea	1855, April 19	Luther.
Calliope	1852, November 16	Hind.
Psyche	1852, March 17	De Gasparis.
Themis	1853, April 5	De Gasparis.
Hygeia	1849, April 12	De Gasparis.
Euphrosyne	1854, September 1	Ferguson.
Lætitia	1856, February 8	Chacornac.
Harmonia	1856, March 31	Goldschmidt.
Daphne	1856, May 22	Goldschmidt.
Isis	1856, May 23	Pogson.
Ariadne	1857, April 16	Pogson.
Nysa	1857, May 27	Goldschmidt.
Eugenia	1857, June 28	Goldschmidt.
Hestia	1857, August 16	Pogson.
Pseudo-Daphne	1857, September 9	Goldschmidt.
Aglaia	1857, September 15	Luther.
Doris	1857, September 19	Goldschmidt.
Pales	1857, September 19	Goldschmidt.
Virginia	1857, October 4	Ferguson.
Nemausa	1858, January 22	Laurent.
Europa	1858, February 6	Goldschmidt.
Calypso	1858, April 4	Luther.
Alexandra	1858, September 10	Goldschmidt.
Pandora	1858, September 10	Searle.
Mnemosyne	1859, September 22	Luther.
Concordia	1860, March 24	Luther.
	1860, September 12	Chacornac.
Danae	1860, September 9	Goldschmidt.
Titania	1860, September 14	Ferguson.
Erato	1860, September 14	Dr. Förster. M. Lesser.
Ausonia	1861, February 11	De Gasparis.
Angelina	1861, March 6	Tempel.
Maximiliana	1861, March 10	Tempel.
Maia	1861, April 10	Tuttle.
Asia	1861, April 18	Pogson.
Leto	1861, April 29	Luther.
Hesperia	1861, April 29	Schiaparelli.
Panopea	1861, May 5	Goldschmidt.
Feronia	1861, May 29	Peters.
Niobe	1861, August 13	Luther.

Even in this very brief sketch of the progress of astronomy, the recent application of photography to celestial objects by Mr. Warren de la Rue, and the discovery of the willow-leaf structure of the solar surface by Mr. Nasmyth, must not be omitted. The first appears destined to afford most valuable aid in extending our knowledge of the physical structure of the

members of our solar system, whilst the last gives us new and altogether unexpected information regarding the condition of the surface of the sun, the value of which, when taken in connection with the recent physico-chemical discoveries of Bunsen and Kirchoff relating to the constituents of the sun's atmosphere, can scarcely be overrated. [SPECTRUM ANALYSIS.]

For further information on this extensive and very important science, we must refer the reader to the particular terms which belong to it, and also the general terms, COMET, MOON, PLANET, SATELLITE, STAR, SUN. The physical theory of the planetary motions will be found explained under GRAVITATION; and astronomical instruments described under their respective names. Works on astronomy are so abundant in every European language, that it could serve no purpose to make any references to them in this place.

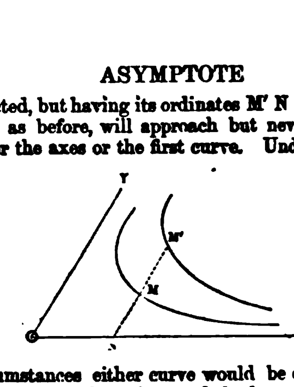
Asylum (Gr. ἄσυλον, from ἀ neg., and συλάω, *I rob*). A place of refuge to which criminals might fly, and from which it was held impious to remove them by force. This right of protection did not belong to all altars or temples, but was attached by the laws to certain spots in different places. When the privilege was not legalised, any means short of actual violence might be employed to remove men from the sanctuary. The Greek cities possessing this right of asylum had in the time of Tiberius become so numerous, that the senate, for the better administration of justice, greatly reduced their number and restricted their privileges.

The asylum, which Romulus is said to have opened, at Rome, was in later times a spot carefully walled in, which no one was allowed to enter. It is probable that the legend arose from a misinterpretation of the word, by which the inviolability of the spot was transferred to those who might take refuge within it.

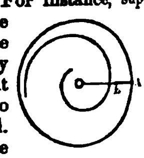
In its modern signification, the word means a place set apart for the care and protection of persons who by misfortune or disease may need such help. The most prominent of such places are asylums for the blind, deaf and dumb, lunatics, and the destitute. Few things distinguish a civilised from a savage state of society more than institutions which have for their object the benefit of those who, by moral or physical defects, are incapacitated for the purpose of self-exertion. In the heathen states of Greece and Rome even hospitals were unknown. On the subject of asylums in England and France, the reader will find in parliamentary papers, and in the reports of managers, a mass of information at once amusing and instructive.

Asymptote (Gr. ἀσύμπτωτος, *not falling together*). A right line or curve which continually approaches, but never meets, a given curve.

A curve whose ordinates M N are inversely proportional to the corresponding abscissæ O N will clearly approach both axes incessantly but never intersect either, however far it may be produced. A second curve similarly constructed, but having its ordinates M′ N twice as long as before, will approach but never meet either the axes or the first curve. Under such



circumstances either curve would be called an asymptote of the other, and both would have the axes for *rectilinear* asymptotes. Two curves, neither of which have infinitely distant points, may also be asymptotic. For instance, suppose a radius O A of a circle to rotate incessantly in the same direction, and in every position a portion A B cut off inversely proportional to the angle it has described. The point B once inside the circle will never be able to leave it again, or even to reach the circumference, which it will incessantly approach. In this case the circle is said to be asymptotic to the spiral described by B.



An algebraic curve of the n^{th} order, although it may have an unlimited number of asymptotic curves, cannot have more than n rectilineal asymptotes, and may have none whatever. In geometrical language, however, a curve of the n^{th} order is always said to have n *real* or *imaginary* asymptotes, the latter being regarded as tangents at the n real or imaginary points where the infinitely distant right line intersects the curve. Thus viewed, the determination of the asymptotes of a curve is merely a particular case of the more general problem, to find the tangents at the n points in which a curve of corresponding order is cut by any given right line.

A parallel to an asymptote must cut the curve in an infinitely distant point, and conversely a line which does so cut a curve must be parallel to an asymptote. This circumstance leads at once to a simple method of finding the *directions* of the asymptotes. In fact, the terms of the highest (or n^{th}) dimension in the equation to the curve, when equated to zero, represent the n real or imaginary right lines through the origin which are parallel to the n asymptotes. The directions of the asymptotes being thus known their actual positions can be easily determined. In fact, the equation of the curve being written in the form

$$x^n\phi_n\left(\frac{y}{x}\right) + x^{n-1}\phi_{n-1}\left(\frac{y}{x}\right) + \&c. \ . \ . = 0$$

where in general $\phi_i(a)$ indicates a function of a of the i^{th} degree, and the equation of the required asymptote in the form

$$y = ax + b,$$

a will be one of the roots of the equation $\phi_n(a) = 0$, and the b which corresponds to it

will have the value $b = -\frac{\phi_{n-1}(a)}{\phi'_n(a)}$ where ϕ'_n denotes the first derived function of ϕ_n.

Asymptotic Cone. A tangent cone to a surface whose curve of contact is situated in the plane at infinity. The asymptotic cone of a central quadric $Ax^2 + By^2 + Cz^2 = 1$ is represented by the equation $Ax^2 + By^2 + Cz^2 = 0$; that is to say, it has its vertex at the centre of the quadric, and has the same axes and cyclic planes as the latter surface. Its focal lines are the asymptotes of the focal hyperbola of the quadric. [CYCLIC PLANES, FOCAL LINES, &c.]

Asynarteta (Gr. ἀσυνάρτητος, from ἀ neg., and *συναρτάω, I connect*). In Grammar, sentences irregularly or ungrammatically connected.

Asyndeton (Gr. ἀσύνδετος, from ἀ neg., *συνδέω, I connect*). In Rhetoric, a figure by which the conjunctions in a sentence are omitted: as in the famous phrase of Cæsar, 'Veni, vidi, vici.'

Atacamite. A hydrated oxychloride of copper, originally obtained from the Atacama Desert, between Chili and Peru.

Atè (Gr.). In the Mythology of Homer, is the spirit of Mischievous Folly. As such, she is hurled out of heaven by Zeus for postponing the birth of Hercules to that of Eurystheus. Before the time of Æschylus, the word had passed into the meaning of a Fate or Doom, resting on a house, after the shedding of innocent blood.

Ateles (Gr. ἀτελής, *imperfect*). A genus of South American monkeys, characterised by the absence or rudimental condition of the thumb of the anterior hands. The deterioration of these members as prehensile organs is compensated by a very efficient prehensile tail.

Atellanæ Fabulæ (Lat.). Rustic comedies which had their origin among the Oscan inhabitants of Campania, from a town of which country, Atella, they derived their name; they are of some importance in the early history of the Latin stage.

A Tempo Giusto (Ital. *in correct time*). In Music, a direction to the performer, generally after a recitative, to keep the measure true and correct, which, during the recitative, was performed irregularly, to suit the action and passion of the scene.

Athalamous (Gr. ἀ, *without*, and θάλαμος, *a chamber*). Lichens whose thallus is not furnished with shields or beds for the spores; in these the reproductive matter is supposed to be dispersed through the substance of the crust, as in *Lepraria*.

Athamantine. A crystallisable substance contained in the root of the *Athamanta* (now *Peucedanum*) *Oreoselinum*.

Athanasian Creed. A confession of faith, described in the rubric of the Common Prayer Book, which appoints it to be read on certain days, as commonly called the Creed of St. Athanasius. That it was really composed by that father is more than doubtful: modern divines seem generally to assent to the judgment of Waterland, who considers it to have been written by Hilary, bishop of Arles.

Athanor. A term applied by the alchemists to a furnace so constructed as to supply itself with fuel.

Atheling or **Ætheling** (A.-Sax.). A name given among the Anglo-Saxons to the heir apparent or presumptive to the crown.

Athenæum (Lat.). A school under this name was founded at Rome by the Emperor Hadrian, and appears to have been an important institution for some centuries. Another foundation under the same name existed at Lyons.

Athereastite. An altered Scapolite, which it resembles both in form and appearance. It is green and opaque, and is found at Arendal in Norway.

Athericera (Gr. ἀθήρ, *a point*, and κέρας, *a horn*). The name given by Cuvier and Latreille to one of the primary divisions of the Dipterous order of insects. It comprehends the modern families *Syrphidæ*, *Astridæ*, *Conopidæ* and *Muscidæ*, in all of which the antennæ have only two or three joints, the last being furnished with a bristle.

Atherina. A Linnæan genus of Abdominal fishes, having an elongated body, two widely-separated dorsal fins, and a very protractile mouth armed with very small teeth. All the known species have a broad silvery band along each side, and six branchiostegal rays. It was to the fishes of this genus that the ancients attributed an origin by equivocal generation; and the inhabitants of the shores of France which are washed by the Mediterranean still call them 'nonnats.'

Athermanous (Gr. ἀ priv., and θερμός, *heat*). Transparent or translucent substances which resist the passage of radiant heat.

Atheroma (Gr.). In Medicine, a soft tumour, generally contained within a cyst or bag.

Atherospermaceæ (Atherosperma, *one of the genera*). Incomplete aromatic Exogenous shrubs found in New Holland and South America, remarkable for having their flowers in a cup-shaped involucre, and the peculiar anthers of *Lauraceæ*.

Athletes (Gr. ἀθλητής, from ἆθλος, *a contest*). Men who contended at the public games of the Greeks and Romans, in boxing, wrestling, running, leaping, and throwing the quoit. The name was more particularly applied in the two former cases. They fought naked, having had their bodies previously anointed by the Aliptæ. The boxers used a kind of glove called cæstus or cestus, which consisted of leather thongs wrapped round the hand and loaded with pieces of lead and iron, to give greater weight to the blows.

Among the Greeks these contests were considered highly honourable, and the victors at their national games at Olympia, and elsewhere, were received in their native states with great distinction. The special attribute of Polydeukes, or Pollux, one of their most

popular deities, was his skill in wrestling. Among the Romans the athletes were trained persons, hired from the lower ranks, or slaves and foreigners.

Atlantes. A name given by Vitruvius to the male figures which were introduced, instead of columns, to support the cornice of a building, such as those in the temple of Jupiter Olympus at Agrigentum.

Atlantic Ocean. This portion of the great ocean extends from the Arctic to the Antarctic Circle, but the part fairly enclosed by land on both sides is about 7,000 miles in length. Its breadth, which is less than 1,000 miles between Greenland and Norway, extends to 1,800 miles at the equator, and is about 4,000 miles at its greatest width between Florida and the coast of northern Africa. Its area is estimated at 27 millions of square miles.

The opposite coasts of this great canal correspond in their general outline. Those on the east side are remarkable for their indentations, and on both sides the inland seas and gulfs are more considerable than in the same distance in other parts of the world. The total length of coast line is estimated at 55,300 miles. The drainage area connected with this ocean is extremely large, but the great rivers are confined to the American side.

Many parts of the Atlantic are very deep, but the general form of the sea bottom is that of a large trough descending by successive platforms and not by gradual slopes.

Several of the most important inland seas open into the Atlantic. On the European side are the Baltic and the Mediterranean, the latter including the Black Sea. On the opposite side are Hudson's and Baffin's Bay, the Gulf of Mexico, and the Caribbean Sea.

Atlantides (Gr.). In Astronomy, a name given to the Pleiades, because they were supposed to be daughters of Atlas, or his brother Hesperus, who were translated to heaven.

Atlantis (Gr.). An island mentioned in Plato's Dialogue entitled 'Timæus,' as having once existed in the Atlantic Ocean opposite to the Pillars of Hercules. It was said to have exceeded Europe and Africa jointly in magnitude; and after existing for 9,000 years to have been submerged in the ocean. The question of the reality and site of this island has been frequently discussed by modern geographers. M. Bailly supported the Platonic view, and cited Homer and Diodorus Siculus in corroboration of his opinion. Rudbeck, Kircher, Beckman, and others, concur in opinion respecting its reality, but each assigns to it a different locality. According to the conjectures of Buffon and Whitehurst, who regarded the Canaries and the Peak of Teneriffe as the summits of mountains belonging to some submerged continent, Atlantis was the land which, at a former period, united Ireland to the Azores and the Azores to America. On the other hand, D'Anville and Heeren regard Plato's account of the Atlantis as altogether a fanciful speculation: while many discover in it proofs that the American continent was known at some remote period to the people of the Eastern hemisphere.

Atlas (Gr.). In Anatomy, is the term applied to the uppermost of the cervical vertebræ; so named from its supporting the head, as Atlas was supposed to support the heaven.

Atlas. In Mythology, a son of Iapetus and Clymene, or of Æther and Gaia, and brother of Prometheus. He bore up the heavens on his head and hands. Hesiod. *Theogony*, 507 &c.

Atlas. A rich kind of satin, manufactured in India. It was formerly in great demand, but is now little used.

Atlas Mountains. A broad belt of mountain land, extending parallel to the north coast of Africa and separating the Mediterranean from the low lands of the desert of the Sahara, has been known from classical times by this name. As a mountain system it consists of three parts; the Greater Atlas, which is the innermost and loftiest range; the Lesser Atlas, which is a coast range; and the Middle Atlas, chiefly a rich table land.

The Greater Atlas extends from the Atlantic coast to the Lesser Syrtis, and forms an important mountain knot in Morocco, rising to a height of 15,000 feet and covered with perpetual snow. Further to the east the chain, though lofty, is below the snow line during the middle of summer.

The Lesser Atlas commences at Cape Spartel opposite Gibraltar, and runs due east at a great elevation till it dies away in the plains of the desert towards Egypt. A long rugged chain forms the African coast opposite Spain, and is covered with snow during many months of the year. The intervening country is partly table land and partly mountain, but is for the most part rich and capable of cultivation.

Atmidometer. Babington's atmidometer is an instrument for measuring the evaporation from water, ice, or snow. It consists of an oblong hollow bulb of glass or copper, beneath which, and communicating with it by a contracted neck, is a second globular bulb, duly weighted with mercury or shot. The upper bulb is surmounted by a small glass or metal stem, showing a scale graduated to grains and half grains; on the top of which is fixed horizontally a light, shallow metal pan, of about five inches area. This instrument being immersed in a vessel of water, through a circular hole in the cover of which the stem rises, distilled water is gradually poured into the pan above, which is thus caused to sink, until the zero of the stem is brought to a level with the cover of the vessel. Thus adjusted, as the water in the pan evaporates, the stem ascends, and the amount of evaporation is indicated in grains. These indications are the only satisfactory means we possess of measuring evaporation from ice or snow. An adjustment for temperature is furnished with the instrument.

Atmometer (Gr. ἀτμός, *vapour*, and

μέτρον, *measure*). An instrument for determining the rate of evaporation from a humid surface.

Atmosphere (Gr. ἀτμός, *vapour*, and σφαῖρα, *a sphere*). The assemblage of gases and vapours which form the invisible medium surrounding the earth. For an account of the different gases which enter into the composition of atmospheric air, see Air. We shall here confine ourselves to the mechanical properties of the atmosphere.

Weight of the Atmosphere.—It is well known that the rise of water in the sucking pump, and the retention of the column of mercury in the barometric tube, are caused by the pressure of the atmosphere; we have therefore, in either of these phenomena, the means of measuring its weight. The column of mercury in the tube of a barometer is exactly equal in weight to a cylinder of air of equal diameter reaching to the top of the atmosphere. A column of mercury whose base is a square inch, and height the mean height of the barometer, weighs 14·6 lbs. avoirdupois nearly; so that the atmosphere exerts a pressure equal to 14·6 lbs. on every square inch at the surface of the earth.

This pressure of the atmosphere plays a very important part in the animal and vegetable economy. Like that of all other fluids, it is exerted equally in all directions; thus the air in a tube presses not only on the bottom but also on the sides of the tube, with a force equal to 14·6 lbs. for every square inch. The surface of a man of ordinary stature is about 15 square feet, or 2,160 square inches, whence the whole atmospheric pressure which his body sustains amounts to the enormous sum of 31,536 lbs. This great pressure is not sensibly felt, because it is balanced by the reaction of the elastic fluids in the interior of the body; but if the equilibrium were to be suddenly destroyed, the consequences might be fatal. Under the exhausted receiver of an air-pump, animal life is soon destroyed; on the summit of a very high mountain a man experiences extreme fatigue, the pulse is accelerated, and sometimes blood starts from some of the tender parts of the body, in consequence of the diminished pressure.

Density of the Atmosphere.—The density of the atmosphere is not the same at different distances from the surface of the earth, but diminishes with the altitude in a complex ratio.

Height of the Atmosphere.—There are various methods of obtaining an approximate estimate of the height of the atmosphere. One of them, proposed by Kepler, is derived from observations on the twilight, which is occasioned by the power the atmosphere possesses of refracting and reflecting light. It is generally assumed that twilight ceases when the sun has descended 18° below the horizon. Now it may be considered that this takes place when a ray of light proceeding from the sun, and passing by the surface of the earth, just reaches the highest stratum of the atmosphere, and is reflected back to the earth in the direction of a tangent to its surface at the place of observation. On this principle it is calculated that reflection cannot take place at a greater altitude than 45 miles. There are various considerations which lead us to infer that the height of the atmosphere cannot be much less than this, whilst there are others which render it highly probable that the extreme altitude is much greater. Though we are unable to assign the precise boundaries of the atmosphere, there are phenomena which indicate that it has a limit, and that it does not extend indefinitely into the celestial spaces, but belongs exclusively to our earth.

Effects of the Atmosphere on Light.—Like all other diaphanous substances, the atmosphere deflects oblique rays of light from their rectilinear course. This phenomenon is called refraction. It increases the apparent elevation of all the celestial bodies above the horizon; but, fortunately for astronomy, its effects can be rigorously calculated. The atmosphere also, notwithstanding its transparency, intercepts and reflects the rays of light, or objects would not be illuminated unless exposed to the direct light of the sun. The illuminating power of the atmosphere is so feeble, that to an eye placed in the shade the stars are visible in broad day.

The colour of the gas or air which composes our atmosphere is blue. The tint is, however, so slight that it cannot be appreciated by the eye unless clouds are absent and a mass of it several miles thick be viewed at once.

Atmospheric Railway. A system of propulsion which has been resorted to on some railways, in which motion is given to the carriages by connecting them with a piston rod, which in its turn is moved by the diminished pressure of the air on one side of a cylinder; the piston moves along a tube which runs parallel to the railway, and the success of the system depends upon the degree of perfection attained in securing the closing down of the joint, through which the connecting rod passes; for evidently the perfection of the vacuum must be, in the end, regulated by the power of the air-pump to maintain the diminished pressure on the front.

In the Atmospheric Railways of England and France, the system consists in placing along the length of the railway a large cast-iron tube, in which a piston moves bearing a rod, to which is fixed the wagon, by a bar. A longitudinal groove is left in the upper part of this tube to give passage to this bar; and the piston being set in motion drags it along the groove, and gives motion to the train. The groove is covered by a valve, which is raised to allow the bar to pass, and is then closed. A stationary air-pump creates a vacuum in the great tube upon one side of the piston, which is then urged forwards by the pressure of the air on the other side; the tube is closed at both ends. The valve is composed of leather, with stiffening pieces of iron rivetted

through, and is fixed to the seating by an iron bar, is compressed upon the seating by a rod which follows the piston, and is soldered with a species of grease consisting of wax and tallow. Special appliances are required for the passage from a main line to a siding, as in stations, and for the passage of level crossings, which have been met with considerable success, but which nevertheless complicate the service of these railways so much as to induce many engineers to regard them as inapplicable to a great line upon which an active service is maintained. The reader who may desire to examine the various opinions upon the working of the Atmospheric system is referred to the elaborate report by the late Robert Stephenson upon the subject; in it he will see the objections faithfully recorded, and the various reasons by which that engineer was induced to recommend that it should not be adopted.

The Atmospheric system has been applied in some other cases, with no better success, to a method of producing the motion by a compression of the air, in a tube running along the railway and serving to retain the force there accumulated. This method is found in practice to be very defective; it is, in fact, far too complicated to be of easy application, and it is exposed to the greater part of the objections which have been urged against the system by means of exhaustion. The whole system of atmospheric traction is, however, now nearly abandoned; and the improvements in the locomotive render it less likely than ever to be adopted, although when its use was originally proposed it was believed that the conditions of heavy inclines were such as to justify its introduction.

Atmospheric Stones. [AËROLITE.]

Atmospheric Tides. Diurnal oscillations of the atmosphere, produced by the attractions of the sun and moon, and similar to the tides of the ocean. This tidal action is so small that Laplace, after many experiments, thought its *sensible* existence doubtful. But in the *Philosophical Transactions* for 1847, Colonel Sabine gives an account of a series of observations of the barometer made at St. Helena, *hourly*, during a period of three years, which show an average excess of barometric pressure of ·0014 parts of an inch at the hour when the moon is on the meridian (above or below the pole), and an average defect of ·00115 when six hours distant from the meridian, making together an average difference of ·00255 in. when the moon is on the meridian and when 90° from it. Observations reduced at Woolwich show the average difference to be ·00365 in., or nearly four-thousandths of an inch. These differences are, no doubt, exceedingly minute; but as the observations were made with great care, and on being broken up into periods of six months were still found to give consistent results, it may be reasonably presumed that they represent with considerable accuracy the amount of the lunar influence on the atmosphere. The effect of the sun's attraction, being not only much smaller than that of the moon, but also marked in the diurnal barometric oscillation by the much greater and variable influence of the solar heat, probably cannot be satisfactorily determined.

Atoll or Lagoon Island. In Physical Geography, the name given to a particular kind of coral island. The Atoll consists of a chaplet or ring of coral, enclosing a lagoon or portion of the ocean in its centre. The average breadth of the part of the ring which rises above the surface of the sea is nearly a quarter of a mile, and it seldom rises higher than from six to ten or twelve feet above the surface. On the outer side the ring gradually shelves down to the distance of 100 or 200 yards from its edge, so that the sea deepens to about 25 fathoms, beyond which the sides plunge almost perpendicularly into the unfathomable depths of the ocean. On the lagoon side, where the water is calm, the bounding ring or reef shelves into it by a succession of ledges, also of living coral, but of a different species from those which build the exterior wall, and the foundation of the whole ring. The size varies from two to ninety miles in diameter. The lagoon islands are widely spread, but are found chiefly in the Pacific Ocean. Most frequently they occur in elongated archipelagos, extending in groups over a large surface; the Carolina Islands, for example, extend to 1,000 miles. Sometimes the lagoons have islands within them: Otaheite, the largest of the Society group, is a remarkable instance of this formation. The lagoon which encompasses it is thirty fathoms deep, and hemmed in from the ocean by a coral band of the usual kind, at a distance varying from half a mile to three miles. (Somerville, *Physical Geography.*)

Atom (Gr. ἄτομος, from ἀ neg., and τέμνω, *I cut*). A part so small as not to be divisible.

Atomic Theory. In Chemistry. When substances combine chemically, they are found to unite in certain weights; thus, water is constituted of one part by weight of hydrogen and eight of oxygen, and the gases only combine in those proportions to form it. It is assumed that water is a compound of an atom of hydrogen and an atom of oxygen, and that the relative weight of the atom of hydrogen to the atom of oxygen is as 1 : 8; hence the atomic weight of water is $1+8$, or $=9$. The same theoretical views are applicable to all other simple and compound bodies, and the numbers which repesent their combining weights are hence called their atomic or equivalent numbers. [EQUIVALENT; AFFINITY.]

Atomogynia (Gr. ἄτομος, *uncut*, and γυνή, *a female*). A word proposed to be substituted for angiospermia, the name of the second order of the sixth class of Linnæus, signifying that the ovary is not cleft into distinct parts.

Atonement. In Theology. [SACRIFICE.]

Atrium (Lat.). The name given by the Romans to the most important room in a dwelling-house. It was roofed over, with the exception of an opening in the centre called

compluvium, under which was a cistern in the floor to receive the rain-water discharged into it from the sloping roof above. The atrium has by many been identified with the *Cavum ædium*, while others have maintained that the former term signified only the covered part exclusive of the compluvium. Originally the only sitting-room and kitchen of the house, it became at length in the dwellings of the rich a reception-room, distinct from all the private apartments, adorned with marble columns and fitted up with great magnificence. (Smith's *Dictionary of Greek and Roman Antiquities.*)

The name was also applied to a class of public buildings which resembled the atrium of a private house, as the Atrium Publicum of the Capitol. (Livy xxiv. 10.)

Atropa (Gr. ἄτροπος, *inflexible*). The Solanaceous genus to which belongs the belladonna or deadly nightshade. This is an herbaceous perennial, bearing brownish-purple bell-shaped flowers, succeeded by berries which towards autumn become black and shining. All parts of this plant are highly poisonous. [BELLADONNA.]

Atrophy (Gr. ἀτροφία; ἀ neg., and τρέφω, *I nourish*). A wasting away of the flesh.

Atropia (Gr. ἄτροπος). A poisonous alkaline substance, extracted from the *Atropa Belladonna*.

Atta. The name of a Fabrician genus of Hymenopterous insects belonging to the ant-tribe (*Formicidæ*), characterised by their very minute palpi, and the large size of the heads of the neuters. Some of the largest species of ant, as the visiting ant of South America (*Formica cephalotes*, L.), are included in this genus.

Attachment. In Law, a process issuing in a summary manner from a court of record against the person of any one guilty of a contempt of its rules. Attachment is most commonly granted against attorneys for malpractice, against sheriffs for making a false or no return to a writ, and against any parties neglecting to pay costs when ruled to do so.

ATTACHMENT, FOREIGN. Under the custom of the city of London, whenever process for debt from the mayor or sheriffs' court is returned nihil, the plaintiff may, upon its appearing that a third person is indebted to the defendant, obtain satisfaction of his claim by attaching the debt. This is called foreign attachment.

Attainder, Bill of. A species of extraordinary proceeding against parties accused of treasons or felonies which cannot be reached by the ordinary course of justice. During the reigns of the Tudors the more constitutional process of impeachment was entirely laid aside, and attainders were generally adopted in the case of state criminals. These bills usually commenced in the Lords. They have been very unusual in later times: the last recorded in Mr. Hatsell's *Precedents of Parliament* was directed against some persons concerned in the Scotch rebellion in 1746. Parliament is now bound, in passing these acts, to adhere to the rules of evidence which are followed in ordinary courts of justice.

Attainder is the supposed stain or corruption of the blood of a criminal legally condemned, which, by the common law of England, immediately follows the pronouncing sentence of death. The attainder of a criminal follows upon judgment, and not upon conviction. Attainder is either on appearance (by confession or by verdict) or by process, otherwise termed by default or outlawry, in case of non-appearance. For the effect of attainder on the lands, &c. of the criminal, see FORFEITURE. It is enacted by 54 G. III. c. 145, that no attainder for felony, except in cases of high treason, petty treason, or murder, or abetting and counselling the same, shall extend to the prejudice of the rights of any persons except the offender during his life.

Attalea. A genus of lofty palms, one of the species of which, *A. funifera*, yields the Piassaba fibre, used in Brazil for ropemaking, and in this country for the manufacture of what are called bast-brooms. Another species yields the coquilla nut, much used in turnery.

Attar, Ottar, or **Otto of Roses.** The odorous oily principle of roses. [OTTAR.]

Attelabus (Gr. ἀττέλαβος). The name of a Linnæan genus of Coleopterous insects, characterised by moniliform antennæ, thicker towards the tip, and situated on the rostrum: the head pointed behind, and inclined. The species thus heterogeneously grouped together are now divided into the genera *Attelabus* proper, *Apoderus*, and *Rhynchites*. The latter includes some of the most beautiful weevils in this country, amongst which is the rare and splendid *Curculio auratus*.

Attention (Lat. *attentio*). In Metaphysics, a steady exertion or application of the mind to any object of sense or intellect, in order thoroughly to understand and retain it. Attention is regarded by Stewart (*Inquiry into the Human Mind*, ch. 2) as a distinct faculty of the mind; and though this arrangement does not coincide with the views of many philosophers, his illustrations of the results or effects of attention are universally considered as a masterpiece of metaphysical disquisition.

Attenuants. Remedies which dilute the blood.

Attenuatus (Lat. *made thinner*). When the thickness of any part diminishes in some particular direction, it is often used in the sense of narrowed, or angustate.

Attic. In Architecture, a low story above an entablature, or above a cornice which marks the height of the main part of an elevation. The origin of the word is very doubtful. Professor Goldstücker refers it to the Sanskrit, *attaka*, a room on the top of a house. (*Transactions of the Philological Society*, 1854.)

Attic Base. In Architecture. [BASE.]

Atticism (Gr. ἀττικισμός). An elegant or concise form of expression. Milton, in his

Apology for Smecsymnus, thus uses it: 'They made sport, and I laughed: they mispronounced, and I misliked; and, to make up the atticism, they were out, and I hissed.'

Attire. In Heraldry, the horns of stags, &c., used in emblazoning coats of arms.

Attorney (from the modern Latin torno, whence attorno, attornatus, signifying one who serves the *turn*, or is set in the place of another to do his business; and 'attornment,' signifying the assent of a tenant to the substitution of a new landlord on alienation of land). An attorney is either private or public. A private attorney is a person who acts for another in the conduct of his affairs out of court: for which purpose a verbal authority is in general sufficient, but for the performance of some acts, as, to deliver seisin of land, to transfer bank stock, or to execute a deed for another, he must be authorised by a formal power of attorney. He is not necessarily of the profession of the law; and the above, and all other the various matters unconnected with actual litigation in which he may be employed, such as the preparation of legal instruments, and the giving of advice and assistance in the transfer and management of property, may be undertaken by any other person. A public attorney, or an attorney at law, has been defined to be an officer of a court of record, legally qualified to prosecute and defend actions in courts of law on the retainer of clients. The circumstance of his being an officer of the court in which he may practise is important, as bringing him immediately within its summary jurisdiction, and thereby giving rise to his peculiar privileges and disabilities. A solicitor, in strict legal designation, differs from an attorney in practising in courts of equity instead of common law.

The power of suing and being sued by attorney was first given by statute in the time of Edward I. All persons may now appear in court by an attorney of their own appointment, except infants, who must appear by next friend or guardian; and married women, for whom, unless when proceeding in chancery in respect of their separate estate against their husbands, the attorney must be appointed by their husbands. Idiots, and persons charged with any criminal offence, must appear in person; lunatics, if of full age, and corporations, cannot appear otherwise than by attorney.

The admission and practice of attorneys are now chiefly regulated by the Act 23 & 24 Vict. c. 127 (1860) in connection with former acts. The first requisite to be complied with in order to become an attorney is to enter into a contract in writing, called articles of clerkship, on which a stamp duty is payable, with an attorney or solicitor actually practising, or other officer of court specified by statute, to serve him in the capacity of clerk for five years. No attorney or solicitor can take more than two articled clerks at the same time, but some of the officers above referred to are allowed to take three. Persons who have taken the degree of B.A. or B.C.L. at Oxford, Cambridge, or Dublin, within a certain fixed period after matriculation at the university, and before execution of their articles, may be admitted as attorneys after a clerkship of three years. Clerks also who are bound for five years are allowed to reckon as part of their term a year passed as bonâ fide pupils to a barrister or special pleader. After expiration of service, and notice given of his intention to apply for admission, the clerk must go before a board of examiners established by the judges, and his fitness and capacity having been approved, be sworn in open court to demean himself honestly in his practice. His name is then entered on one of the records of the court, called the roll of attorneys, and he is duly admitted an attorney of that particular court. He may, however, when admitted of any one court at Westminster, practise in any one of the other courts there, in the name of an attorney of such other court, with his consent in writing. He may, at a trifling expense, be admitted a solicitor in any of the courts of equity, as a solicitor in equity may in like manner be admitted an attorney of any of the courts of common law. After admission he must pay a certain duty, and obtain his certificate. Should he for one whole year neglect to take out his certificate, he would, besides incurring a penalty for practising without one, be thenceforth incapable of acting in court in any professional character; but upon payment of all arrears of duty since the expiration of his last certificate, and of a further sum by way of penalty, he may be readmitted.

An attorney actually practising is supposed to be always present in court, and has for that reason many privileges in common with its other officers. He is accordingly exempted from serving on juries and inquests, and generally from filling all offices which require personal service; he has the privilege in all personal actions of suing in his own court. He is in general privileged from giving evidence of any confidential communication made to him by his client: this, however, is the privilege not of the profession but of the client, who may waive it if he please. An attorney cannot fill the office of justice of the peace, sheriff, and many other offices, and cannot be bail for another unless in criminal cases. He is not permitted to deal with his clients in the same unrestrained manner in which ordinary men may deal with each other; and when a purchaser of his client's property, is sometimes required to show affirmatively in the first instance that he has given for it its full value. To restrain him from extortionate and vexatious conduct, he is required, one month at least before bringing an action to recover fees for business done in court, to deliver to his client a bill of costs, which, upon application of the client and his undertaking to pay what shall appear due, will be taxed by an officer of the court, and if exorbitant be reduced to a fair and reasonable amount. Where an attorney has been guilty of gross ignorance, neglect, or misbehaviour, in the management

of his client's business, the court will interpose in a summary manner, and compel the attorney to pay the costs, or make a reparation for any loss occasioned by his default; and in cases of fraudulent malpractice grant an attachment against him, or even strike him off the roll. He is besides liable to an action for any gross and culpable negligence, by which the interests of his client may have been prejudiced. In matters of difficulty, not lying within his own department of the profession, he is protected from responsibility by acting on the opinion of counsel; but in matters of simple and ordinary practice, where the law will presume him to have the requisite knowledge himself, he cannot avoid his responsibility by consulting another.

Attorney-General. An officer made by letters patent. He is the public prosecutor on behalf of the crown, his duty being to exhibit informations in criminal matters which concern the crown, ex officio, or by virtue of his office. [INFORMATION.] He also files bills in the exchequer for any thing concerning the king's inheritance and profits, and bills are filed against him by others. The attorney-general has precedence of all other counsel. As chief legal adviser of the crown, in all matters falling within the purview of his office, his place is one of great importance, and is usually entrusted to new hands whenever an extensive change is made in the cabinet. It is generally understood that the attorney-general for the time being has a priority of claim for preferment to any of the high law offices which may fall vacant, if he is willing to accept it; but this rule has by no means been uniformly acted on.

Attraction (Lat. attractio, from ad, *to*, and traho, *I draw*). A term used in physics to denote the tendency which we observe in certain bodies to approach one another, and to resist separation.

Attraction, with reference to the laws which it observes, may be divided into two kinds; one, taking place among bodies placed at measurable distances from each other; the other among the small particles of matter, where the effect is seen only at insensible or inappreciable distances. Among the instances of attraction, even at the greatest distances, the most remarkable is that of the attraction of gravitation, which belongs to all matter; which determines the motions and the figures of the planets and comets, and causes the descent of heavy bodies to the ground. For an account of the law which this species of attraction observes, and the astronomical phenomena which it produces, see GRAVITATION. The attraction of magnetism, of electricity, &c., are also instances of the action of bodies on each other at sensible distances. [ELECTRICITY; MAGNETISM.]

The second species of attraction exists only among the molecules or small particles of matter, and is hence called molecular attraction. The distances to which it extends are extremely small, or insensible. This species of attraction is the cause of the coherence of solids; of crystallisation; the ascent of fluids in capillary tubes; the roundness of a drop of water; and of all chemical actions. [CAPILLARITY; COHESION; CHEMICAL AFFINITY.] The law of molecular attraction is not known; all that can be positively affirmed of it is, that it decreases in a much quicker ratio than the inverse square of the distance, and in many instances becomes prodigiously great, when the distance between the particles is diminished to its utmost limit.

Attraction, Calculus of. An important branch of applied Mathematics whose general object is the determination of the mutual action of bodies each of whose particles are supposed to attract (or repel) one another according to a known law. In all applications to the theories of Gravitation, the Earth's figure, Electricity, Magnetism, &c., this law is that of Newton, according to which the attraction between two material particles is a force whose direction coincides with the line joining the latter, and whose intensity is *directly* proportional to the *masses* of the particles, and *inversely* proportional to the square of their distance asunder. In the solution of the general problem of attraction, even when the attracted body is assumed to be a material point, great mathematical difficulties have to be overcome: the attempts that have been made, since Newton's time, to overcome these difficulties have contributed not a little to the perfection of mathematical methods. The history of the problem is not without interest; a sketch of it, with indications of other sources of information, will be found in a memoir by Chasles, *Sur l'Attraction des Ellipsoides*, Paris, 1846.

The modern calculus of attraction may be said to be based upon the properties of a certain function of the coordinates x, y, z, of the attracted point, to which function Gauss, in his celebrated memoir entitled *Allgemeine Lehrsätze in Beziehung auf die im verkehrten Verhältnisse des Quadrats der Entfernung wirkenden Anziehungs- und Abstossungs-Kräfte*, gave the name *Potential*. This function is defined by the formula,

$$v = \int \frac{dm}{r},$$

where dm is the mass of the attracting element, and r its distance from the attracted particle; the integration being extended throughout the attracting mass.

Amongst the properties of the potential above referred to, the following two are the most important: *First*, the components of attraction in the directions of the co-ordinate axes are proportional to the first partial differential coefficients $\frac{dv}{dx}, \frac{dv}{dy}, \frac{dv}{dz}$.

Secondly, the sum $\frac{d^2v}{dx^2} + \frac{d^2v}{dy^2} + \frac{d^2v}{dz^2}$ of the second partial differential coefficients is equal to zero, when the attracted point is outside the attracting mass, and to $-4\pi\rho$ when it is within,

ϱ being the density of the attracting mass immediately around the attracted point. Of these values 0 and $-4\pi\varrho$, the first was given by Laplace, the second by Poisson.

The series of surfaces whose equations are obtained by putting v equal to a constant magnitude, have been called by Gauss and Chasles *surfaces of equilibrium* (surfaces de niveau), the direction of the resultant attraction at any point being always normal to the surface of equilibrium which passes that point. In many questions, and particularly in the theory of electricity, these surfaces play an important part.

Amongst the authors to be consulted on the calculus of attractions the following may be mentioned:— Newton; Maclaurin; Simpson; Lagrange, *Memoirs of Berlin Academy*, 1774–5; Legendre, *Mémoires de l'Académie des Sciences*, 1783; Laplace, *Mécanique Céleste*; Ivory; Gauss; Poisson; Jacobi; Green, *Application of Mathematical Analysis to the Theories of Electricity and Magnetism*; Chasles; Liouville; Cayley; W. Thomson, &c.

Attraction, Chemical. [AFFINITY.]

Attraction of Mountains. That power or force by which all the celestial motions are regulated, and to which we give the name of gravitation, does not act merely on the large masses of the universe; the smallest molecules of matter equally partake of its influence, and have an inherent and natural tendency to approach one another. This mutual action, in the case of small bodies, is insensible; because the attraction resulting from the whole mass of the earth absorbs, as it were, altogether, that which they exercise on one another, and renders their mutual approach infinitely small or imperceptible. But though the attractive force of matter is insensible in regard to small masses, it may become quite appreciable in the case of large mountains acting on the plummet of a delicate astronomical instrument. Newton himself was the first who deduced this consequence from his theory of universal gravitation. Some time elapsed, however, before any attempt was made to investigate the subject experimentally.

There are various ways by which the quantity of the attraction of a mountain may be ascertained. One of the most obvious is to take two stations, one on the south and the other on the north side of the mountain, and as nearly as possible in the same meridian. From the zenith distance of the same stars observed at each station, the difference of their apparent latitudes may be accurately determined. But the real difference of the latitudes can also be determined by a trigonometrical measurement on the ground of the distance between the same stations. The difference of these determinations gives the sum of the deviations of the plumbline on the opposite sides of the mountain; and when divided in the inverse ratio of the squares of the distances of the stations from the centre of gravity of the mass, will give the deflection of the plummet at each station. But it is not absolutely necessary, indeed it may be impracticable, to make observations on the opposite sides of the mountain. Let the meridian altitudes of the same stars be observed first on north or south sides of it, and then at a station on the same parallel of latitude, but at such a distance from the mountain as to be out of the reach of its action. The difference of the altitudes in the two cases will show the amount of the attraction of the mountain.

The first attempt to ascertain the attraction of a mountain by actual observation was made by the French academicians, Bouguer, Godin, and Condamine, who, about the year 1738, were despatched to Peru for the purpose of measuring the length of an arc of the terrestrial meridian. Their experiments were made on the mountain Chimboraço, the highest of the Cordilleras, and the result seemed to show that the zenith point was altered by the attraction of the mountain to the extent of about 7½ seconds of a degree. But this quantity was much too small to determine, with certain evidence, whether the mountain had or had not a sensible effect on the plumbline, for their instruments were not so perfect but that inconsistencies, amounting sometimes to upwards of 20 seconds, entered into their observations. From that time no farther attempt was made to determine this interesting fact in physical astronomy till the year 1774, when Dr. Maskelyne, the astronomer-royal at Greenwich, made an experiment of the same kind on the mountain Schehallien in Perthshire, with instruments capable of measuring the minute quantities in question. The difference of latitude of two stations on the north and south side of the mountain, compared with that which was inferred from the measurement of the distance on the ground, gave decidedly 5·8 seconds on each side, for the action of the mountain on the plummet of the zenith sector. The magnitude of the mountain was accurately measured at the same time, and with the data thus obtained a laborious calculation was made by Dr. Hutton, from which it resulted that the mean density of the earth is about five times that of water, or twice that of the ordinary rockstone near its surface. A third experiment of the same kind was made in 1810 by Baron Zach on the mountain Mimet, at a little distance from the shore of the Mediterranean near Marseilles. The instrument which he employed for determining the latitudes, a repeating circle of 12 inches radius, was much less to be depended on for accurate results than the zenith sector of Dr. Maskelyne; but in other respects his operations, particularly those connected with the terrestrial measurements, appear to have been conducted with far greater science and practical skill. The result was, that the deviation of the plumbline from the true vertical, caused by the attraction of the mountain, reached two seconds of a degree. Baron Zach did not attempt the further researches required for comparing the density of the mountain with

that of the earth; such comparison, indeed, can only be made with respect to an insulated mountain, which Mimet is not.

Though the experiments hitherto made on this subject are few and imperfect, they are quite sufficient to establish the fact, that mountains are capable of producing sensible deflections of the plumblines of astronomical instruments. It is, therefore, of very great importance, in the measurement of degrees of the terrestrial meridian, to select for the station where the astronomical latitudes are observed places remote from large mountains, and where the local irregularities of the surface are not very considerable. After every precaution of this sort has been taken, some uncertainty will still remain, on account of local attraction; for it is obvious that a sudden and considerable variation of density in the strata under the surface will produce the same effect on the plumbline as a mass of matter elevated above it. To this cause is attributed, with much probability, a great part of the discrepancies between the results of operations made to determine the figure of the earth, and more particularly for ascertaining the variations of density by means of the pendulum. (See Zach, *Attraction des Montagnes*, Avignon, 1814; Playfair, *Works*, vol. iii.; Hutton, *Tracts*, vol. ii.; *Phil. Trans.* vol. lxviii.; also Bouguer, *Figure de la Terre.*)

Attribute (Lat. attributus, part. of attribuo, *I assign*). In Logic, the same as Predicate. [PREDICATE; LOGIC.] Hence words expressing that which is affirmed or denied concerning something (such as adjectives) are called by some writers on grammar attributives.

Attributes. In the Fine Arts, certain symbols which are used to distinguish and characterise certain figures. Thus the eagle and thunderbolt are the attributes of Jupiter; the trident that of Neptune; the caduceus that of Mercury; the bow and quiver attend Love; the balance and sword accompany Justice, &c. &c. Nearly all the various saints have their distinctive attributes. (See Husenbeth, *Emblems of Saints*, &c. 1850.)

Attwood's Machine. A pulley, the pivots of which rest on wheels to diminish friction in rotation. It is used in demonstration of the laws of uniformly accelerated motion. [GRAVITATION.]

Aubaine, Droit d'. In French Jurisprudence, the right of the sovereign to the succession of a foreigner not naturalised, or of a naturalised foreigner dying intestate without heirs resident within the realm. The word is derived from the old French aubain, *foreigner*, said to come from the Latin alibi natus, *born elsewhere*. The droit d'aubaine still exists in various countries; and, although abolished at the Revolution, was restored by the Code Civil of Napoleon.

Auchenia (Gr. αὐχήν, *the neck*). In Mammalogy, this term is restricted to the region of the neck, below the nucha or nape. Also, the name of a genus of *Camelidæ*, comprising the llama, guanaco, vicuna, and alpaca, in which this region of the neck is remarkably elongated.

Auditor (Lat.). One who examines and verifies the accounts of officers and others entrusted with money. The term is derived from the Latin audio, *I hear*: probably from the ancient practice of delivering accounts vivâ voce. Receivers-general of fee-farm rents, &c. are termed auditors. Officers with the same title are assigned by courts of law to settle accounts in actions of account, &c. The auditors of the exchequer were officers appointed to take the accounts of receivers of public revenues. The present board of commissioners for auditing the public accounts, exercising the duties formerly divided between various officers of the exchequer, was constituted in the year 1806. In Germany the junior legal functionaries are termed auditors. Its most usual sense seems to have been originally given to the word in France, where the members of the Chambres des Comptes were divided into conseillers-maîtres and conseillers-auditeurs.

Auerbachite. A silicate of zirconia, of a brownish-grey colour; named after Dr. Auerbach. It is nearly allied to Zircon in form and composition, but differs from it in inferior hardness and specific gravity. Probably it is altered Zircon in which a portion of the zirconia is removed.

Auger (A.-Sax. nafgar). A carpenter's boring-tool for piercing the holes to be traversed by large bolts, or treenails. It is made with an end able gradually to force an entrance, and is curvilinear in plan, to allow the tool to clear itself as it pierces through the wood; the sides are made slightly concave, towards the direction of the axis of the tool. The term Auger is also applied to an instrument for determining the quality of soils, the nature of the rocks or strata upon which they lie, and the presence of springs of water.

Augite (Gr. αὐγή, *splendour*). A crystalline mineral common in volcanic and basaltic rocks. It is the *pyroxene* of Hauy.

Augmentation, Arms of. In Heraldry, coats given by sovereigns to subjects as a mark of honour, to be quartered with their own; or charges, such as ordinances charged with some device, to be borne in their family shield. Such coats or devices are in general either significant, i. e. bearing some relation to the nature of the achievement for which the honour is bestowed; or they are portions of the royal arms.

Augmentation of Stipends. In the church of Scotland the stipends of ministers are under the control of the Court of Session. That court has the power to entertain applications for augmentation from clergymen, and either to grant or dismiss them. But twenty years must elapse before such application can be renewed.

Augsburg, Confession of. A formulary drawn up by Luther and Melancthon, and presented to Charles V. at the diet held at Augsburg in 1530. It is adopted by the Lutheran church, but did not at the time succeed in comprehending all the reformers, and

was the occasion of a separation between the followers of Luther and the party who called themselves the Evangelical Reformed Church, which has continued ever since.

Augurs (Lat. augur). Roman soothsayers, who professed to foretel events by the flying, singing, or feeding of birds. Their office was one of great importance in the state, as no enterprises or ceremonies were performed unless they declared the omens favourable. Accordingly the members of their college were always elected from the most honourable citizens. Their divinations were called auguries or auspices, between which there is sometimes a distinction made; the latter meaning such as were derived from the inspection of birds, the former being extended to all omens or prodigies whatever. The Romans derived their knowledge of augury from the Etruscans, who were celebrated for their skill in this and other religious ceremonies.

August. The eighth month of the year. The ancient Roman year commenced with March, and the sixth month was called Sextilis. The name was changed to August in compliment of Augustus Cæsar. In the calendar of Julius Cæsar the distribution of the days through the several months was more commodious than the present arrangement. The first, third, fifth, seventh, ninth, and eleventh months consisted of thirty-one days each, and the other months of thirty, excepting February, which in common years contained twenty-nine days, but in leap years thirty. In order to gratify the frivolous vanity of Augustus, who thought it a disparagement that the month bearing his name should contain fewer days than July, which was named after the first Cæsar, a day was taken from February and given to August. Such was the origin of the capricious distribution of the days among the different months which now prevails over the whole Christian world; and which, being founded on no principle, requires some pains to be remembered.

Augustales. The epithet given to the priests or flamens of Augustus Cæsar. [FLAMEN.]

Augustan Age. A term used to designate the reign of Octavius, more commonly known as Augustus Cæsar, the most brilliant period in the literary history of Rome. Among the poets who then flourished, the greatest were Virgil, Horace, Propertius, Ovid and Tibullus. But it was not merely for ornamental literature that the age in question was distinguished. The science of jurisprudence, the only original intellectual possession of great value to which the Romans can lay undisputed claim, then received its full developement: the immense masses of Roman statutes were perspicuously arranged; and the boundaries of strict law on the one hand, and equity on the other, were respectively ascertained. In this age, too, the wealth of Rome, as the seat of a vast empire, was greatly increased; and so numerous and splendid were the buildings with which it was embellished, that they justified the saying of Augustus—that he found Rome of brick, and left it of marble.

Augustan History. A series of histories of the Roman empire from the year 157 A.D. to 285 A.D., ascribed to the following six authors: Delius Spartianus, Julius Capitolinus, Æl. Lampridius, Vulcatius Gallicanus, Trebellius Pollio, and Flavius Vopiscus.

Augustine. In Ecclesiastical History, an order of monks and nuns established in the eleventh century, apparently in commemoration of the monastic societies assembled by Saint Augustine in the fourth, but which had long ceased to exist. [ORDERS, ECCLESIASTICAL.]

Augustinians. In Ecclesiastical History, divines who held, on the supposed authority of Saint Augustine, that grace is effectual, from its nature, absolutely and morally, and not relatively and gradually.

A sect of the sixteenth century, under this name, maintained that the gates of heaven will not be opened till the general resurrection.

Aula Regia (Lat. *King's Hall*). In English Law, a Court established by William the Conqueror, and regulated by Magna Charta: which may be said to have merged in that of King's Bench.

Aulic Council, or Reichshofrath. A council of high powers and dignity in the German empire. The Aulic Council and Imperial Chamber (reichskammergericht) were the two supreme courts in that empire. The former consisted of a president, vice-president, and eighteen councillors, six of whom were Protestants, with the peculiar privilege that, if unanimous, their votes could not be overruled by those of the Catholics. This court had exclusive jurisdiction in various affairs, principally those which concerned the imperial government.

Aulostoma (Gr. αὐλός, *a pipe*; στόμα, *a mouth*). A genus of Acanthopterygians belonging to the family called by Cuvier *Bouches en flute*; including the pipe-fishes, or those species which are characterised by a mouth which is lengthened into a kind of tube or pipe.

Aura (Lat. *air*). In Botany, the subtle essence which is contained within the grains of pollen, and in which is supposed to reside the power of fertilising the ovules. It is now generally considered that this essence is imaginary, and that fertilisation is produced by the descent of minute organic particles through the stigma to the ovules.

AURA. A sensation resembling a wind, or the being breathed upon. *Aura epileptica* is a sensation often experienced by epileptic patients, resembling the ascent of a blast of cold air from the extremities upwards.

Aurantiaceæ. A considerable natural order of Exogens, with polypetalous flowers, confined to the warmer parts of Asia, or the nearest parts of Africa. They have dotted leaves filled with a fragrant oil; and succulent eatable fruit, covered by an aromatic skin. The orange, the shaddock, the lime, the lemon, are all species of the genus *Citrus*, and the best

known in Europe. In the woods of India there are some species that climb; and in the Himalayas, China, and Japan exist species of *Skimmia* which are found to be hardy evergreens in this country.

Aurantiin. A neutral crystalline principle obtained from the spongy part of the peel of lemons and oranges.

Aurates. Crystalline compounds of auric acid, or peroxide of gold.

Aurelia. In Entomology, the name given to the nymph, or quiescent state of transformation of an insect, on account of the metallic golden lustre which is reflected from the case of the nymphs of some diurnal Lepidoptera.

Aureola, Aureole (Lat. aureolus, *golden*). In Painting, the golden glory with which painters decorate the heads of the saints, martyrs, and confessors. There are various kinds of glories: the circle or *Nimbus*, which, when it encloses a cross, belongs to Christ alone; when without it, indicates canonised saints: and the radiation of gold lines, which is given to persons whose lives have been considered worthy of imitation, and are called *Beati* or Blessed, but who have not been canonised by the church. There is also the *Vesica*, or almond-shaped aureole, called by the Italians *Mandorla*; it is given to the Lord, or the Virgin Mary holding the infant Christ: it surrounds the entire figure. It is called Vesica from its resemblance to a bladder, and was originally derived from the form of a fish, used by the early Christians to symbolise the Lord, from the Greek word ἰχθύς (ichthus), containing the initials of the following sentence—Ἰησοῦς Χριστὸς Θεοῦ Υἱὸς Σωτήρ—Jesus Christ, the Son of God, the Saviour.

Aureus. A Roman gold coin worth a little more than sixteen shillings, according to the proportion given by Tacitus. But it varied, as appears from the different values assigned to it, from *1l. 4s.* to *12s.* It weight was about 2½ oz. avoirdupois.

Auric Acid (Lat. aurum, *gold*). A term frequently applied by chemists to the *peroxide of gold*.

Aurichalcite (Lat. aurum, *gold*, and Gr. χαλκός, *copper*). A carbonate of zinc and copper occurring in acicular crystals. It is found in small groups of a pale-green or blue colour at the Rutland Mine, near Matlock in Derbyshire; at Roughten Gill in Cumberland; also at Loktefskoi in the Ural and at Retzbanya in Hungary.

Auricle (Lat. auricula, *a little ear*). Signifies in Mammalogy, the external ears, which are said to be 'marginate' (*auriculæ marginatæ*) when bordered by a helix, or involute margin; —to be 'operculate' (*auriculæ operculatæ*) when provided with a largely developed tragus, which stands out like a subsidiary auricle;—to be 'concealed' (*auriculæ absconditæ*) when covered by the hair. In Ornithology, the circle of feathers surrounding the entry to the ear-passage are called auriculars. In Anatomy, the venous chambers of the heart are termed auricles.

Auricula (Lat.). A genus of terrestrial Pulmoniferous Gasteropoda, in which the shell is oblong, with thick dark epidermis; spire obtuse; aperture long, narrow, rounded in front, with two or three strong folds on the inner lip; outer lip expanded and thickened. They frequent salt marshes, damp hollows, and places overflowed by the sea; they were long regarded as marine animals, and their shells confused with those of *Tornatella* and *Ringicula*. (Woodward, *Man. Mollusca.*)

Auricular Confession. In Theology, confession of sins to a priest in private, distinguished from the public confession which was enjoined as a duty by the primitive church but was early allowed to drop into disuse. It was on occasion of the scandal which the original practice produced, that Leo the Great, in the fifth century, first recommended private confession to a priest in certain cases. It was not till the fourth council of Lateran in 1215, that the doctrine of the necessity of this practice was formally established.

Auriculate (Lat. auricula). When the base of a leaf or similar part projects on each side of the axis in the form of a little round lobe.

Auriflamme. [ORIFLAMME.]

Auriga (Lat. *the charioteer*), one of the ancient northern constellations situated between Perseus and Gemini. It contains the star Capella of the first magnitude.

Auripigmentum (Lat. from aurum, *gold*, and pigmentum, *paint*). Yellow sulphide of Arsenic. [ORPIMENT.]

Aurocyanides. Compounds of the cyanide of gold with basic oxides. The aurocyanide of potassium is used in the art of electro-gilding.

Aurohydrocyanic Acid. A combination of cyanide of gold with hydrocyanic acid.

Aurora (Lat.). In Mythology, the goddess of the morning. She is the same as the Greek goddess Eos, the daughter of Hyperion and Euryphaessa. The legends about Eos are as varied as those which relate to Apollo. In the beautiful myth of Cephalus, she is the rival of Procris, who represents the morning dew. Another legend spoke of her as the wife of Tithonus, son of Laomedon, king of Troy: for whom, when she asked and obtained immortality, she forgot to ask perpetual youth. It is from his couch that Virgil speaks of her as rising to bring back light after the hours of darkness. In Homer she is also the mother of Memnon, at whose death she is said to weep tears of morning dew.

Milton, in a passage teeming with poetic imagery and truth, thus opens the fifth book of Paradise Lost:—

> Now Morn, her rosy steps in th' eastern clime
> Advancing, sowed the earth with orient pearl;
> When Adam waked, so customed, for his sleep
> Was aëry, light, from pure digestion bred
> And temperate vapours bland, which th' only sound
> Of leaves and fuming rills, Aurora's fan,
> Lightly dispersed, and the shrill matin song
> Of birds on every bough.

Aurora Borealis (Lat.). *Northern lights, Polar lights*, or *Streamers*. An electrical phenomenon generally appearing in the northern part of the sky, and presenting a light somewhat resembling the dawn or break of day. The appearances which it exhibits, and the forms it assumes, are so proverbially unsteady, that it is not possible to comprehend them under any general description. Most frequently the phenomenon appears to proceed from a sort of horizontal cloud or haze in the northern part of the sky, rising a few degrees above the horizon, and stretching from the north towards the east and west, so as to form an arc, which in some instances has been observed to extend upwards of 100°. The upper edge of the cloud is whitish and luminous, the lower part often dark or thick, and sometimes the clear sky may be seen between it and the horizon. From the upper part of the cloud streams of light shoot up in columnar forms, reaching sometimes only a few degrees, sometimes to the zenith, or even beyond it. Instances occur in which the whole hemisphere is covered with coruscations; but the brilliancy is greatest, and the light strongest, in the north near the main body of the meteor. The streamers have in general a tremulous motion, and, when close together, present the appearance of waves or sheets of light following each other in rapid succession. When several columns, issuing from different points, meet at the zenith, a small meteor is formed of greater brilliancy than the separate columns. The phenomenon sometimes continues a few hours, occasionally the whole night, and even for several nights in succession. It generally commences at most two or three hours after sunset, and very rarely in the morning or much after midnight. Auroras have been observed even before the evening twilight has disappeared. In the Shetland Islands, and other countries in high latitudes, the northern lights are the constant attendants of clear and frosty evenings in winter. They are most frequent in autumn.

Although the aurora borealis is most frequently seen in the northern hemisphere, yet several observers have witnessed it in high southern latitudes.

This phenomenon is due to electric discharges passing through highly rarefied air in the upper regions of the atmosphere; a similar appearance may, in fact, be artificially produced by causing electric sparks to pass through a glass vessel containing rarefied air.

Aurora-red. The term applied in Mineralogy to minerals of a red colour mixed with much yellow; as in some kinds of Realgar.

Aurotellurite. A variety of Sylvanite from Nagyag in Transylvania, where it occurs disseminated and crystallised in small four-sided prisms of a silver-white colour inclining to brass-yellow and sometimes to grey.

Aurum Musivum. An obsolete chemical name of the artificial bisulphide of tin, commonly known as *Mosaic gold*.

Auscultation (Lat. auscultatio). A method of distinguishing healthy and diseased states of the body by the study of the sounds produced by the movements of the different organs. These sounds differ more or less when the parts are diseased from those which belong to their healthy functions. [STETHOSCOPE.]

Auspices. [AUGURS.]

Australia. This important tract of land—the smallest of the continents but very much larger than all the islands of the earth together—is the principal detached land of the southern hemisphere. It measures about 2,800 miles from east to west, and 2,000 miles from north to south, and has an area of nearly 4,000,000 of square miles. The whole of the west and the greater part of the south coasts are almost without indentation. The east coast is also little broken. The north and the south-easterly coasts are broken by some large and important bays.

Australia is crossed by the Tropic of Capricorn, which divides it into two unequal parts. It is thus partly tropical and partly temperate, but owing to the form of the land the climate of the interior is singularly dry, and is subject to long summer droughts. There are in its compact mass few well-marked lofty mountain chains, and few navigable rivers of importance discharging their waters into the sea. There are no important lakes, though very large pools of water are collected at intervals in the wet season. In some respects Australia resembles Africa, especially in the absence of a great central mountain range influencing the drainage. It is, however, less adapted to be the residence of large quadrupeds, and has a less luxuriant vegetation, though, perhaps, its climate is on the whole better fitted to the habits and wants of tribes of men accustomed to active exertion and the modern forms of civilisation.

Wanting the commanding natural features which characterise Europe, Asia, and the two Americas, and which are even present in Northern Africa, Australia, though long since peopled to some extent from England, has remained till lately an unknown country. It has now been everywhere coasted, and has been surveyed to some distance in the interior—it has been entered from the east and south across the mountains and to the rivers, and most of the rivers have been followed for some distance into the interior. Very recently it has been crossed completely, and all doubt as to the condition of the interior is set at rest. There can be no further difficulty in understanding its geographical and physical condition, though much more time will elapse before its interior is rendered available.

A large part of Central Australia consists of a low table land, imperfectly watered, covered only at intervals with vegetation, and barren and dry during some months of the year. Partial deserts intervene between tracts of large size susceptible of cultivation, and there is every probability that as man advances, and

encourages vegetation, the climate will improve, and the drought become less trying.

The best districts of Australia as at present known are the fringes of land on the south, south-east, east, and northern parts of the land, and the banks of the rivers derived from the western flanks of the eastern mountain chain: narrow strips on the west coast are also regarded as capable of cultivation, but they hardly seem to lead into the interior.

Mountain systems.—About a hundred miles from the east coast, but approaching the coast towards the north, and receding from it towards the south, is the important chain of the Blue Mountains or Australian Alps, whose height generally varies from 2,500 to 4,700 feet above the sea, though a few isolated peaks rise to nearly 7,000 feet. This is the principal and almost the only mountain chain of any kind in the whole land. Numerous spurs proceed from it.

River systems.—The only important river systems of Australia are those connected with the western flanks of the principal mountain chains. These drain the whole of that comparatively small portion of the continent. The Murray and its tributaries—the principal being the Darling river—belong to the colonies of South Australia and Victoria, and give great value to these colonies. The chief gold districts of Australia are in the country which the waters flowing into this river traverse. Small rivers empty themselves into the ocean on the north coast, and in the Gulf of Carpentaria, but they are not navigable more than a short distance into the interior. The west and south-west coasts are singularly unbroken. For a long distance no stream whatever seems to enter the ocean, while the small rivers known on the west coast do not penetrate beyond the low hills of the coast range.

Authentic, Authenticated (Gr. αὐθεντικός). In Diplomatics, ancient MSS. were formerly termed authentica when originals, in opposition to copies. In the modern acceptation of the word, it is only applied to instruments bearing marks of having been executed by the proper authority.

Authentic Melodies. In Music, such as have their principal notes contained between the key-note and its octave. This term is applied to four of the ancient church modes or tones in music which rise a fourth above their dominants, which are always fifths above their finals, that is, rise to complete their octaves, thus distinguished from plagal melodies, which fall a fourth below their finals.

Autobiography. This word is made up of three Greek words, and signifies literally *the life of a person written by himself.* Such memoirs may be divided into two classes: those in which the chief object of the writer is to illustrate the history of his own mind and heart, and the manner in which these were swayed by the destinies of his life; and those in which his purpose is merely to give a sketch of the scenes and events which have occurred within his own experience, and of characters with which he has been brought in contact. To the first class of writings belong the Confessions of Saint Augustine, whence Rousseau borrowed the title of his own 'Confessions.' In the more strictly narrative class, Julius Cæsar, Napoleon, Cardinal de Retz, Frederick the Great, are among the great men who have left us in greater or less detail the narratives of their achievements.

Autocarpious (Gr. αὐτός, and καρπός, *fruit*). A name given to such fruit as consists of nothing but pericarp, without any additional organ, such as a calyx, adhering to the outside.

Autochthons (Gr. αὐτόχθονες). The Greek term for the aboriginal inhabitants of a country, implying that they were sprung from the soil. The Athenians, whose territory, as they maintained, had been held by the same race from time immemorial, chiefly on account of its sterility which offered no incitement to foreign aggression, particularly laid claim to this title, in memorial of which they wore the emblematic grasshopper as part of their head-dress. [Aborigines.]

Autocrat (Gr. αὐτοκράτωρ). A title given to Athenian generals when invested with full command by the republic. In modern political phraseology, the term autocrat, signifying a sovereign possessed of absolute power, is usually confined to the emperor of Russia.

Auto-da-Fé (Port. *act of faith*; Ital. atto di fede). A public solemnity held by the Court of the Inquisition in Spain and Portugal. It was a gaol delivery, at which extracts from the trials of offenders, and the sentences pronounced by the judges, were read; after which, absolution was conferred on those who were penitent and discharged. Those who were condemned to death (relajados) were then transferred to the secular authority: and here the auto, properly so called, ended; the execution of the victims taking place immediately afterwards, under the authority of the civil judge, a secretary to the Inquisition attending. The ceremonial of the autos, processions, horrible executions, &c. are amply described by many writers. See especially Llorente's *History of the Inquisition; A Relation of the Inquisition in Portugal*, published by Bishop Burnet; and Olmo's *Account of the General Auto-da-Fé at Madrid* in 1680. Autos were of several sorts: the public general act (auto publico general), to which the above descriptions apply; the particular act, at which only the officials of the Inquisition were present; autillo, or little act; and auto singular, the condemnation of a single individual. [Inquisition.]

Automatic (Gr. αὐτόματος, *self-acting*). In Physiology, a term applied to those muscular actions which are not dependent on the will or other act of the mind: such are the successive contractions of the hollow viscera of organic life, e.g. the heart, the intestines, the ureters, urinary bladder, the uterus; the involuntary movements of respiration; the motions of the muscles

of the eye during sleep; the persistent contraction of the sphincters. [REFLEX; MOTORY.]

Automaton (Gr. *self-acting*). A name applied to pieces of mechanism so constructed as to imitate the actions of living animals. The term Android (from the Gr. ἀνήρ, *man*) is sometimes applied to such machines as resemble the figures and imitate the actions of mankind.

The extent to which these useless but ingenious contrivances have been sometimes carried is very surprising. The following are a few of the best authenticated instances:—The flute-player of Vaucanson, described by D'Alembert in the *Encyclopédie Méthodique*, was exhibited in Paris in 1738. It played on the flute exactly in the same manner as a living performer, and commanded three octaves, the fullest scale of the instrument. Its height was nearly six feet. In Hutton's *Mathematical Recreations*, a description is given of an automaton group, constructed by M. Camus for the amusement of Louis XIV., consisting of a coach and horses, with coachman and page, and lady inside, &c., by which the action of driving up, alighting, presenting a petition to the king, and setting off again, were mimicked with wonderful accuracy. In 1741, Vaucanson produced a flageolet-player, which played the flageolet with the left hand, while it beat a tambourine with the right. He also produced a duck, which dabbled in the water, swam, drank, and quacked like a real duck; raised and moved its wings, dressed its feathers with its bill, took barley from the hand and swallowed it. (Montucla, *History of Mathematics*, iii. 802.)

Automaton flute-players have likewise been exhibited in this country, of the size of real life, which performed ten or twelve duets. Maelzel, the inventor of the metronome, exhibited an automaton trumpeter at Vienna, of which a description is given in the *Journal des Modes* for 1809. It was a martial figure, in the uniform of a trumpeter of an Austrian dragoon regiment, which played the Austrian and French cavalry marches, and all the signals of those armies. (*Dictionary of Musicians*, London, 1827.) For other instances of automata, see *Penny Cyclopædia*; Hutton, *Math. Dictionary*; *Encyc. Brit.*, art. 'Androides.'

Automolite (Gr. αὐτόμολος, *a deserter*). A crystalline mineral consisting chiefly of alumina and oxide of zinc. It is the Zinc-spinelle of some authors. The name has reference to the presence of oxide of zinc in a mineral not resembling a metallic ore.

Autopsy (Gr. αὐτοψία). Ocular evidence.

Autumn (Lat. Auctumnus). The third of the four seasons of the year. In a popular sense it denotes that period of the year in which the fruits of the earth are gathered in. Astronomically speaking, it is the time during which the sun is passing from the autumnal equinox to the winter solstice. Owing to the elliptic form of the earth's orbit, the seasons are not all of the same length; and owing to the precession of the equinoxes, their lengths vary a little from age to age. In the present century, the time which elapses between the sun's passage through the autumnal equinox and his reaching the winter solstice, or while he passes through the three signs of Libra, Scorpio, and Sagittarius, is 89 days 16 hours and 47 minutes. The autumn of the northern hemisphere corresponds to the spring of the southern.

Autumnal Equinox. The day on which the sun passes through the equator, going southward, or on which his declination changes from north to south. When the sun is in the equator, the day is equal in length to the night all over the world. [EQUINOX.] The autumnal equinox falls generally on the 22nd or 23rd of September.

Autumnal Point. One of the two points in which the ecliptic intersects the equator. It is the same as the first point of the sign Libra.

Autunite. A mineralogical synonym for the Uranite of Autun in France. It has also been found in Cornwall.

Auxiliary Verbs. In Grammar, those which are said to 'aid' the sense of other verbs; as 'to have,' 'to be.' The peculiarity of the classical, as distinguished from the principal modern European languages, consists in the absence (in the former) of these verbs, the place of which is supplied by inflexion of the original verb.

Avalanches (Fr.). Masses of snow which collect upon the heights of mountains, and rapidly sliding down their sides acquire enormous bulk by fresh accumulations; when they ultimately reach the valleys below, they often cause great destruction.

Avanturine or **Aventurine.** A variety of rock-crystal, having a spangled appearance generally caused by scales of Mica, but sometimes by minute octahedral crystals of copper. The name is borrowed from that of the artificial gold-spangled glass, made in imitation of the natural stone. This glass having been produced in the first instance by the accidental (*par aventure*) dropping of some brass filings into a pot of melted glass, was called *Aventurine*: subsequently the name was applied to the stone of which the glass was an imitation. It is found in Spain, Siberia, India, &c.

Avast. A sea term, signifying enough; stop; cease.

Avatar (Sansc. *a descent*). In Hindoo Theology, the descent on earth, or incarnation, of a divinity for some special purpose. The ten incarnations or avatars of Vishnû are among the most celebrated instances.

Avellana (Abella or Avella, *a town of Campagna, celebrated for its fine filberts*). One of the names of the common hazel nut. The Spaniards in Chili apply the name to the fruit of *Quadria heterophylla*, from its resemblance to filberts.

Avena (Lat.). A genus of corn-bearing grasses, one of which, *A. sativa*, is the common Oat, a tall annual, characterised by a loose com-

pound equal panicle, and two-flowered spikelets. The Oat is extensively cultivated in most of the northern countries of Europe as a bread corn. It has long occupied the same place in Scotland that rye occupies in Germany and the potato in Ireland. In England it is chiefly used for feeding horses; but it is also used to a considerable extent as food for man, particularly in the northern counties. The varieties of the common Oat cultivated in England may be arranged according to their colour—black, grey, dun-brown or red and white. The first two classes, being comparatively hardy, may be raised on inferior soils, and in situations unsuitable for the white. The only black oat now cultivated to any extent in England is the black Tartarian; but many kinds are still raised to a considerable extent in some parts of Scotland, and the Western Islands. The dun or red oat is principally confined to the uplands of Scotland, and some of the northern and midland counties. White oats are, speaking generally, less hardy than either of the other varieties, and require a better soil; but they are also earlier, heavier, and yield a greater quantity of meal. There are numberless, and some widely different, sub-varieties of the white oat. The white Poland oat is the earliest, and the white Canadian the heaviest, of them. That which is called the potato oat has long enjoyed the highest reputation in this country, as a productive sort of good quality. The produce of oats varies very greatly. When the ground is foul or exhausted, not more than 20 bushels an acre may be obtained; but in a rich soil well managed and in favourable years, 60, 80, and sometimes even 100 bushels have been reaped, weighing from 35 lbs. to 48 lbs. a bushel. The price of oats amounted at an average of the 27 years ending with the 31st December 1863, to 23*s.* 2*d.* Imp. quarter.

Aventurine Felspar. [SUNSTONE.]

Avenue (Fr., from Lat. ad, *to*, and venio, *I come*). In Landscape Gardening, is a road forming the main approach to a house; the term is also applied to any broad walk of grass or gravel, bordered on each side by trees or statues or vases recurring at regular intervals. When the modern style of gardening began to take the place of the ancient style, the term avenue gave way to that of approach road, which subsequently became shortened into that of approach.

Average (Ger. haferei, *sea-damage*). In practical Arithmetic is a quantity intermediate between several other quantities, and the sum of the latter is equal to the sum of the same number of magnitudes each equal to the average. See ARITHMETIC MEAN, with which term average is synonymous. It is a common error to suppose that the average of a number of averages is equal to the average of the original quantities.

Average, General. In Mercantile Law, whatever damage or loss is incurred by any part of the ship or cargo for the preservation of the rest. When such damage accrues, the several persons interested in the ship, freight, and cargo, contribute their respective proportions to indemnify the owner of the part in question against the damage or necessary expense which has been incurred for the good of all. General average, therefore, cannot be unless the whole adventure has been in jeopardy. Every species of loss incurred on any part of the cargo in the course of the voyage, is somewhat loosely denominated average, or particular average. [INSURANCE.]

Avernus (Lat.; Gr. ἄορνος, from ἀ neg., and ὄρνις, *a bird*, as being a place over which, owing to its exhalations, no bird could fly). A lake in Italy ten miles west of Naples, celebrated as the entrance to the infernal regions. Virgil speaks of the Cumæan Sibyl as inhabiting a cave adjoining this lake (*Æneid*, vi. 237-242), which Augustus connected with the Lucrine lake, to form by the junction of both the great Portus Julius. This lake still exists under the name Lago d' Averno; it is about a mile and a half in circumference, and in many places 190 feet deep. Averni is a generic name for certain lakes or other places that infect the atmosphere with pestilential vapours.

Averrhoa. A genus of arboraceous Indian *Oxalidaceæ*, named after Averrhoes, a celebrated Spanish physician. *A. Bilimbi*, the Blimbing, and *A. Carambola*, the Carambola, produce fruit which is used in India in preserves and pickles.

Averruncator (Lat. averrunco, *I avert*). In Arboriculture, is an instrument for cutting off the branches of trees, consisting of two blades secured to the end of a rod, one having a movable joint, and by means of a line fixed to it operating like a pair of scissors. In the improved forms of this instrument, the point on which the moving or cutting blade turns, instead of being confined to a circular opening, works in a longitudinal one; in consequence of which, instead of a crushing cut, like that produced by common hedge shears, a draw cut is formed, which leaves the section from which the branch or shoot has been amputated as clean as that produced by a pruning knife.

Averse (Lat. aversus, *turned back*). In Ornithology, when the posterior extremities are attached to the trunk near the anus, so that the body is supported erect, as in the penguin, they are termed '*pedes aversi*.'

Aves (Lat.). The name of a class of warm-blooded vertebrated animals, characterised by a double circulation and respiration, oviparous generation, a covering of feathers, and by their anterior extremities being organised for flight. The posterior extremities present five principal modifications, affording characters which distinguish five primary orders. In the first order the foot (fig. *a*) has three toes before and one behind, all armed with long, strong, crooked, and more or less retractile talons, adapted to seize and lacerate

a living prey; this structure is associated with a strong, curved, sharp-edged and sharp-pointed beak, often armed with a lateral tooth; a very muscular body, and capability of rapid and long-continued flight. This order is termed Raptores or Accipitres. The second type of foot presents three toes before and one behind, and placed on the same level; slender, flexible, of moderate length, and provided with long, pointed, and slightly curved claws. The two external toes are united by a very short membrane. A foot so constructed (fig. *b*) is especially adapted for the delicate operations of nest-building, and for grasping and perching among the slender branches of trees; hence the order so characterised has been termed Insessores, and, from including the smaller tribes of birds, Passeres. In the third type of foot (fig. *c*) the hinder toe is raised above the level of the three anterior ones; this lessens the power of perching; but the other toes are strong, straight, and terminated by robust obtuse claws, adapted for scratching up the soil, and for running along the ground; the legs are for this purpose very

AVES.

strong and muscular, and the order so characterised is termed Rasores, or Gallinæ. The modification by which birds are enabled to wade and seek their food in water along the margins of rivers, lakes, and estuaries, is gained simply by elongating the bones of the leg (tibia and metatarsus), which are covered with a naked scaly skin. The three anterior toes are very long and slender, as in the Parra Jacana, by which the bird can support itself upon the broad floating leaves of aquatic plants; sometimes they are of moderate length. The hind toe is elevated, short, and sometimes wanting (fig. *d*). The order of birds characterised by this form of leg and foot is termed Grallatores, from the resemblance of the posterior extremities to stilts. In the last form of foot (fig. *e*) the toes are united by intervening webs; the legs are placed behind the centre of equilibrium; the body is protected by a dense covering of feathers, and a thick down next the skin; and the whole organisation is especially adapted for aquatic life. Hence the order is termed Natatores.

The following classification of the class Birds has been most generally adopted.

Order 1. *Raptores.* (Diurnes) Falconidæ, Vulturidæ, Gypogeranidæ.
(Nocturnes) Strigidæ.

Order 2. *Insessores.* (Dentirostres) Laniadæ, Merulidæ, Sylviadæ, Pipridæ, Muscicapidæ.
(Conirostres) Sturnidæ, Corvidæ, Buceridæ, Loxiadæ, Fringillidæ.
(Tenuirostres) Cinnyridæ, Trochilidæ, Promeropidæ, Meliphagidæ, Nectarinidæ.
(Fissirostres) Hirundinidæ, Caprimulgidæ, Todidæ, Halcyonidæ, Meropidæ.

Order 3. *Scansores.* Psittacidæ, Picidæ, Cuculidæ, Ramphastidæ.

Order 4. *Rasores.* Columbidæ, Cracidæ, Phasianidæ, Tetraonidæ.

Order 5. *Cursores.* Struthiidæ, Dinornidæ, Dididæ, Apterygidæ.

Order 6. *Grallatores.* Ardeidæ, Scolopacidæ, Rallidæ, Charadriadæ.

Order 7. *Natatores.* Anatidæ, Colymbidæ, Alcadæ, Pelecanidæ, Laridæ.

Aviary (Lat. aviarium). A place for keeping birds. In gardens, aviaries for singing birds are generally limited spaces attached to summer-houses or hot-houses, in which a temperature is kept up during winter suitable to the kind of bird or birds in the aviary. When an aviary contains only birds which live in climates analogous to that of Britain, it is formed in the open garden or pleasure ground, each kind of bird having a separate house, or small inclosure covered with netting. The most common exotic singing birds kept in aviaries are canaries; and the most common exotic ornamental birds are turtle doves, and birds of the parrot tribe. The ornamental and curious birds which live in climates similar to that of Britain may be divided into two classes, the terrestrial and the aquatic. Of the former, the most ornamental are the gold and silver pheasants, and the varieties of the common pigeon; and among the latter, the white and black swans, the Muscovy Duck, &c.

Avicula (Lat. *a little bird*). A name applied to a genus of Bivalves, in some of the species of which, the shell, when expanded, resembles a bird flying. The shell is inequivalve, with a rectilinear hinge, notched at the anterior edge for the passage of a byssus; the anterior adductor muscle very small. To the subgenus Meleagrina belongs the celebrated pearl oyster (*Avicula margaritifera*). In this subgenus the valves are flatter and nearly equal. The 'mother-of-pearl' or nacreous deposit formed on the inside of these shells and

on the 'oriental' pearls of commerce are produced by alternate layers of very thin membrane and carbonate of lime, but this alone does not give the pearly lustre, which appears to depend on minute undulations of the layers. Completely spherical pearls can only be formed loose in the muscles or other soft parts of the animal. The Chinese obtain them artificially, by introducing into the living mussel foreign substances, which produce irritation, and are coated with the nacreous deposit. (Woodward, *Manual of Mollusca.*)

Avoidance. In Ecclesiastical Law, signifies the condition of a benefice when void of an incumbent, and is opposed to plenarty.

Avoirdupois or **Averdupois** (Fr. avoir du pois, *to have weight*). The name given to the common system of weights in England, by which goods in general, excepting the precious stones and medicines, are weighed. The standard weight of this country is the grain, which is ordered by Act of Parliament, 5 Geo. IV. c. 74, to be such that 'a cubic inch of distilled water, weighed in air by brass weights, at the temperature of 62 degrees of Fahrenheit's thermometer, the barometer being at 30 inches, is equal to two hundred and fifty-two grains, and four hundred and fifty-eight thousandth parts of a grain.' A pound avoirdupois contains 7,000 grains. The pound is subdivided into 16 ounces and the ounce into 16 drams. The higher denominations are the quarter-hundred, the hundredweight, and the ton; 28 pounds making a quarter, 112 pounds a hundredweight, and 20 hundredweights a ton. The pound avoirdupois is greater than the pound troy; the latter containing only 5,760 grains. But the troy ounce, which contains the twelfth part of 5,760, or 480 grains, is greater than the ounce avoirdupois, which contains the sixteenth part of 7,000, or 437½ grains. The avoirdupois ounce is considered as being the Roman uncia, which, according to Dr. Arbuthnot, contains 437½ grains, though other authorities make it several grains less. The term averdupois occurs in some orders of Henry VIII., A.D. 1532; and Queen Elizabeth, in 1588, ordered a pound of this weight to be deposited in the Exchequer as a standard. [WEIGHTS.]

Avoset. A wading bird, characterised by a long recurved bill.

Avowry. In Law, the justification advanced in pleading by one who has taken a distress in his own right when sued in replevin. The avowry must contain a sufficient averment of right to have return. One who justifies as having taken in the right of another, is said to make cognisance. [REPLEVIN.]

Award (from Ital. guardare, Fr. regarder, *to look*). In Law, the judgment pronounced by one or more arbitrators, at the request of two parties who are at variance, for ending the matter in dispute without the decision of a public tribunal. The act of reference to an arbitrator is termed a submission.

By the stat. 9 & 10 Will. III. c. 15, it is provided that parties desirous to end a controversy may agree that their submission of the suit to arbitration shall be made a rule of any court of record; and after such rule the party disobeying the award is liable to be punished for a contempt of the court. But the award may be set aside for various causes, as corruption, informality, &c., by motion in court within one term after the award is made. When submission to arbitration has been made a rule of court, it is, by 3 & 4 Will. IV. c. 42, s. 39, not revocable by either party without leave of the court. See the provisions, on the subject of arbitration, of the Act for Farther Amendment of Process and Pleading in the Superior Courts, 1854.

Awn (in Icelandic, ogn). A stiff, usually rough, bristle, proceeding from the end or some other part of a leaf, or of a leafy organ; it is the beard of grasses, and often proceeds in those plants from the base of either glumes or paleæ. An awn is in reality either a vein separating from its parenchyma, or a rigid sharp-pointed barren branch of inflorescence. A part is said to be awned, or aristate, when furnished with this organ.

Awning (Dutch, havenung, *shelter*, as in a haven or harbour). In Horticulture, a temporary covering for plants, generally consisting of cloth of some kind, stretched by means of ropes, cords, or wooden rods, so as to protect fruit trees against a wall, or flowers in a bed. An awning for a tulip bed is the most complete structure of this description, and is so constructed, by means of lines and pulleys, that the sheeting can be either pulled up or let down over a bed of considerable length in two or three minutes.

Axe (A.-Sax. eax). A tool used by carpenters, consisting of a cutting edge of steel, followed by a wrought-iron shaft, into which the handle is fixed parallel to the edge; but the handle is made to work in the same plane as the edge instead of being parallel to it, as in the case of the adze.

Axestone. A name sometimes given to Jade in consequence of its being shaped into axes and other cutting instruments by the New Zealanders. [JADE; NEPHRITE.]

Axiferous (Lat. axis, *a centre*, and fero, *I bear*). A name given to those plants which, like lichens, fungi, &c., consist exclusively of an axis, without any leaves or appendages of it.

Axil (Lat. axilla, *the armpit*). That part of a plant where a leaf fits on a branch, forming an angle with it; or where two branches diverge from each other.

Axile (Lat. axis). Lying in the axis of anything; as an embryo, which lies in the axis of a seed, that is from the base to the end diametrically opposite.

Axilla (Lat.). In Anatomy, the hollow below the base of the arm, at its insertion into the chest. An interesting region in topographical anatomy, containing important arteries, veins, nerves, glands, &c., which are termed 'axillary.'

Axillary. In Botany, growing in an axil. The term is modified by prefixing different Latin prepositions: thus, infra axillary, signifies growing from below the axil; extra axillary, on one side of it; and supra axillary, from above it.

Axinite (Gr. ἀξίνη, *an axe*). An anhydrous silicate of alumina, lime, &c., with boracic acid. The name refers to the form of the crystals, which are generally very oblique rhomboidal prisms, so flat as to appear tabular, and sharp like the edge of an axe. The colour is most commonly brown of various shades, passing into pearl-grey and greyish-black; and the crystals, which have a brilliant lustre, are either transparent or translucent. Very perfect crystals of a clove-brown colour are found near St. Just in Cornwall, and at Lostwithiel, and St. Columb. It is also met with in Devonshire, at Brent Tor, near Tavistock, and on Dartmoor; the principal foreign localities are the Harz, Savoy, St. Gotthard, the Tyrol, the Pyrenees, Norway, Sweden, the Ural, &c.

Axiom (Gr. ἀξίωμα, from ἀξιόω, *I demand*). In Geometry, a proposition which it is necessary to take for granted, and which therefore admits of no demonstration. The following are among the propositions of this kind enunciated by Euclid: 'Things that are equal to the same thing are equal to one another.' 'The whole is greater than its part.' 'If equals be added to equals, the sums will be equal.' 'If two figures when placed the one on the other entirely coincide, they are equal in every respect.' The formal statement of such propositions is totally useless, or rather tends only to produce obscurity.

Axiom. In Philosophy, properly that which is demanded, or postulate. It is used, in the mathematical and physical sciences, in the sense of a proposition, to which the assent of the student is demanded without proof, as a foundation for farther argument.

Axis. In Architecture, a real or imaginary straight line passing through any body on which it may revolve; the axis of a column, for instance, is a straight line drawn down through its centre; the axis of the Ionic volute is a line drawn through the two eyes, front and rear.

Axis. In Botany, that part in plants about which particular organs are arranged. Thus, the stem is an axis for the branches; a branch an axis for the leaves; the rachis, an axis for the divisions of inflorescence; and the receptacle, gynobase, or columella, is the axis of the fruit. The term is also applied to the imaginary point round which parts of any sort are arranged.

Axis. In Mechanics, signifies in general the straight line, real or imaginary, about which a body turns. In this sense it is called the axis of rotation, of oscillation, &c., according to the motion of the body. In Geometry, the axis of a figure is a straight line about which the parts of the figure are symmetrically disposed. Thus, the axis of a cone is the line drawn from the vertex to the centre of the base; and the axis of a cylinder, the line drawn through the centre of its two ends. In the ellipse and hyperbola, the transverse axis is the straight line drawn through the two foci, and the conjugate axis, that drawn through the centre, perpendicular to the transverse. In general, by the axis of a curve line is meant that diameter which has its ordinates at right angles to it. We also speak of the axes of the coordinates of a curve, meaning the lines on which the abscissa are taken.

Axis-cylinder. In Anatomy, the name applied to the central substance of the primitive nerve-fibre.

Axis of the Earth. Is that diameter about which it revolves from west (through south) to east.

Axis of Elevation. The line or direction in which rocks have been elevated from below. This line generally governs the strike of the rocks [Dip and Strike], or the direction of a horizontal line upon them when removed from their natural or original position (which must have been horizontal or nearly so), and inclined to the horizon at a definite angle. [Elevation of Rocks, and Anticlinal and Synclinal.]

Axis in Peritrochio. One of the five mechanical powers, consisting of a peritrochium or wheel fixed immovably to an axle, so that both turn together round the axis of motion. The power is applied at the circumference of the wheel, and the weight raised by a rope wound round the axle. The power gained is the same as that gained by a lever, the longer arm of which is equal to the radius of the wheel, and the shorter equal to the radius of the axle; so that if we suppose the radius of the wheel to be 30 inches, and the radius of the axle 6 inches, a weight of one pound suspended by a rope passing round the wheel would raise a weight of five pounds similarly suspended from the axle.

Axle (Lat. axis, Gr. ἄξων). The part of machinery which forms the centre of the revolving portion, or the immediate bearing of the revolution of a piece of machinery which revolves on its own centre, is called the axle: the term is extended to the whole of such a piece of machinery, and the word axle is made to apply to the shaft which carries the wheels, or other revolving machinery. An axle may be either fixed to the wheels, or it may turn freely; it may be either cranked, or it may be uniform in its diameter; it may be either concentric with the driving machinery, or it may be at right angles to it, or at an inclination varying according to the wants of any particular case.

Axolotl. A term derived from the Mexican language, and applied to a genus of Perennibranchiate Amphibians, found in the lake of Mexico.

Ayapana. *Eupatorium Ayapana*, a sudorific which has the repute of being a remedy for snake bites.

Aye-aye. The name of a singular nocturnal quadruped of Madagascar, indicative of its

peculiar cry; it is placed by Cuvier in the Rodent order, under the generic name Cheiromys, from the hand-like structure of the hinder feet; a structure which approximates the genus to the monkey tribe, or Quadrumana, in which other naturalists have correctly placed it. [CHEIROMYS.]

Aymestry Limestone. An impure clayey limestone often fifty feet thick, distinguished by the presence of some particular fossils (the *Pentamerus Knightii*, *Terebratula Wilsoni*, *Lingula Lewisii*, and some others), and occupying a definite position near the top of the Silurian series in England. The Aymestry limestone lies immediately below the upper Ludlow shales and sandstones. It is subcrystalline in texture.

Azadirine. An alkaloid found in the *Melia Azadirachta*.

Azalea (Gr. ἀζαλέος, *parched*). A group of Ericaceous shrubs allied to *Rhododendron*, and distinguished, amongst other points, by having five instead of ten stamens. Though beautiful garden shrubs, the plants have deleterious properties, one of them, *Azalea pontica*, being charged with the destruction of the army of Xenophon, whose soldiers had eaten freely of honey derived principally from the flowers of this plant. Cattle and sheep also suffer from browsing on its leaves.

Azimuth (from the Arabic). A term used in Astronomy, to denote the arc of the horizon intercepted between the meridian and the vertical circle passing through a star or other celestial body; or the angle made at the zenith by the meridian and the vertical circle in which the body is situated. The azimuth may be counted either from the north or the south point of the horizon; modern astronomers seem to prefer beginning at the north point, and counting eastward and westward to 180°; but it is not one of those elements usually observed in astronomy, being easily deduced from the declination, which can be measured much more conveniently and accurately. In trigonometrical surveys, however, on the earth's surface, the accurate determination of the azimuth of an object is an operation of very great importance. It is usually made with the theodolite.

Azimuth Circles or **Vertical Circles.** Are great circles of the sphere passing through the zenith, and intersecting the horizon at right angles.

Azimuth Compass. A compass used at sea for finding the horizontal distance of the sun or a star from the magnetic meridian.

Azimuth Dial. A dial of which the stile or gnomon is perpendicular to the plane of the horizon. It is so called because the shadow marks the sun's azimuth.

Azoerythrin. A crystalline substance contained in various lichens. It closely resembles orcin.

Azoleic Acid. A product of the action of nitric acid on oleic acid.

Azolitmine. A dark red substance forming a great part of the colouring material of litmus; its chemical formula is, according to Kane, $C_{18}H_{10}O_{8}N$.

Azomaric Acid. A product of the action of nitric acid upon resin.

Azorite. A columbate or tantalate of lime occurring in minute square prisms in an albitic rock in the Azores (whence the name).

Azotane. Sir H. Davy proposed to designate the compounds of chlorine by the termination *ane*, and consequently distinguished the compound of chlorine and azote, or chloride of azote, by the above name.

Azote (Gr. ἀ neg., and ζωή, *life*). A simple gaseous body, unfit for respiration; it forms four-fifths of our atmosphere. [NITROGEN.]

Azotic Acid. A synonym of Nitric Acid.

Azotised Principles. In Chemistry, the term is chiefly applied to substances containing nitrogen, and used as aliments: many of them are common to animals and vegetables.

Azuline. A fine permanent blue dye made from certain constituents of coal tar.

Azulmic Acid. A brown substance deposited from an aqueous solution of cyanogen on exposure to light.

Azure (Fr. azur, *blue*; Ital. azurro). In Heraldry, one of the colours, or tinctures, employed in blazonry. It is equivalent to sapphire among precious stones, and Jupiter among planets. In engraving, it is represented by horizontal lines.

AZURE. In Painting, a sky-coloured blue. That made of lapis lazuli, called ultramarine, is of great value to the painter.

Azure Copper Ore. Blue carbonate of copper. [CHESSYLITE.]

Azure-stone or **Azurite.** [LAZULITE.]

Azygos (Gr. ἄζυγος, *unpaired*). In Anatomy, some single muscles, bones, veins, &c., are so called.

Azymites (Gr. ἀ neg., and ζύμη, *leaven*). In Ecclesiastical History, Christians who administer the sacrament with unleavened bread. The Latins, Armenians, and Maronites are so called.

B

B. The second letter in all European alphabets, and in those of most other languages. B is one of the letters called labial, because the principal organs employed in its pronunciation are the lips. It has a close affinity to the other labial letters P and V; and by the Saxons it is confounded with the former, and with the latter by the modern Greeks, Spaniards, and Gascons. Hence the sarcastic remark, that in Gascony 'vivere' and 'bibere' are the

same thing. Among the Greeks and Hebrews, B signified 2; among the Romans 300; with a dash over it, it denoted 3,000, and with a kind of accent below it 200. The Romans also used it in inscriptions as an abbreviation for Baccho, Beleno, Benemerenti, &c.; B.B. for bene bene (i. e. Optime), B.L. for lector benevole, B.F. (affixed to decrees or senatus consulta) for bonum factum. In modern times also it is used as an abbreviation for *before*, as B.C. (before Christ); and for *bachelor*, as, B.A., LL.B., B.D. (bachelor of arts, of laws, of divinity). In the chemical alphabet, according to Raymund Lully, it denotes mercury.

B. One of the notes in the English musical scale, corresponding to the French *Si*. The Germans, by B standing alone, understand B flat; they call B natural H.

Baal or **Bel** (Heb.). A Phœnician and Syrian god. The term, which is common to all the Eastern languages, signifies lord or master; and the system of Baal-worship was an adoration of a supreme being under the mere attribute of power. Into this form of heathenism the Jews showed a frequent tendency to relapse; and it was the religion adopted by Jeroboam for the ten tribes which had revolted with him from Rehoboam. Some account of the worship of Belus (or Baal) at Babylon is given by Herodotus, book i. 181, &c. Among other sacrifices human victims were sometimes offered up on his altars. The adoption of his name for members of noble families (as in the Carthaginian names, Hannibal, Hasdrubal, &c., and in Belshazzar, &c.) sufficiently proves the devotion of eastern nations to this divinity and the wide extent of his worship. (Selden, *De Diis Syriis*. Shuckford's *Connection*, b. v.)

Baal-berith. The god of the Shechemites (Judg. viii. 33).

Baal-peor or **Baal-phegor.** A god of the Moabites and Midianites (Num. xxv. 3).

Baalzebub. [BEELZEBUB.]

Babel (Heb.). A tower, which the posterity of Noah began to build in a plain in the land of Shinar, the attempt being followed by their dispersion and the confusion of tongues. (Genesis xi.) It is generally supposed that the site of Babel was afterwards occupied by the city of Babylon, where Herodotus saw a structure, which he describes as consisting of eight towers, rising within and above each other and each seventy-five feet high (Herod. i. 181), and which is fancifully supposed by some to have been built from the ruins of the tower. The Orientalists maintain that the original tower was 10,000 fathoms or twelve miles high. St. Jerome asserts, on the authority of eye-witnesses who had examined the ruins of a tower at Babylon, that it was four miles high, and there are other statements still more extravagant. The accounts of modern travellers, who pretend to identify the ruins found on or near the site of ancient Babylon with the town of Babel, are very inconsistent and contradictory. (Rich's *Travels*; Rennel's *Remarks on Herodotus*; Rawlinson's *Herodotus*, vol. ii. p. 574.)

Babiana. A genus of Cape plants belonging to the natural order *Iridaceæ*, having sword-shaped leaves, and spikes of crocus-like flowers. The name is derived from *Babianer*, a term given by the Dutch colonists to these plants in consequence of the avidity with which their fleshy root-tubers are devoured by the baboons.

Babillard (Fr.). The name of a small frugivorous Passerine bird, the *Curruca garrula*: also called the white-breasted or babbling fauvette, lesser whitethroat, and nettle-creeper.

Babingtonite. A silicate of iron and lime. It occurs in dark greenish-black crystals with a vitreous lustre, on the Albite of Norway; and in large laminated crystals imbedded in white Quartz, in one of the Shetlands. Named after Dr. Babington.

Bablah. An astringent dye-stuff imported from the East Indies and from Senegal: it has been used for dyeing drabs, as a substitute for more expensive materials. It is the shell of the fruit of the *Mimosa cineraria*.

Baboon (Fr. babouin; Dutch, baviaan). The monkeys, or quadrumana, which have projecting ridges above the eyes, long and truncate muzzles, cheek-pouches, ischiatic callosities, and generally short tails. They are composed of the genera *Papio* and *Cynocephalus*.

Babyroussa. The name of an animal of the hog kind (*Sus babirussa*, Cuv.) inhabiting the forests of the Indian Archipelago, with longer legs and tusks than the other species of hog; both the upper and the lower tusks curve upwards and backwards, and serve as a defence to the eyes while the animal forces its passage through the entangled jungles.

Bacca (Lat.). A berry; usually a succulent fruit containing several seeds. In its more exact application it is a succulent fruit filled with pulp, in which the seeds lie loosely, as in the gooseberry.

Baccalaureat or **Bachelorship.** The first or lower degree in any faculty, conferred in the English, French, and other universities. At Oxford and Cambridge it is conferred after examination, to which those students alone are admissible who have pursued the prescribed course of study, and (in the ordinary case of Bachelor of Arts) kept the university terms for the space of three years; and sometimes by extraordinary diploma on persons unconnected with the university. The former class are called Baccalaurei Formati, the latter Baccalaurei Currentes. In France the degree of Baccalaureat (Baccalaureus Literarum) is conferred indiscriminately upon such natives or foreigners as, after a strict examination in the classics, mathematics, and philosophy, are declared to be qualified. In the German universities, the title 'Doctor Philosophiæ,' has long been substituted for Baccalaureus Artium or Literarum. In the middle ages, the term Baccalaureus was applied to an inferior order of knights, who came into the field unattended by vassals; from them it was transferred to the lowest class of ecclesiastics; and thence again, by Pope Gregory IX., to the universi-

tiea. There are few words whose origin has been more controverted than that of Baccalaureat; and both the military and literary classes have asserted their claims to this honour with equal zeal and ingenuity. While the former maintain that it is derived either from the *baculus* or staff with which knights were usually invested, or from *bas chevalier* (an inferior kind of knight), the latter trace its origin to the custom which prevailed universally among the Greeks and Romans, and which was followed even in Italy till the thirteenth century, of crowning distinguished men with laurel: hence the recipient of this honour was styled Baccalaureus (quasi *baccis laureis* donatus).

Baccha. In Entomology, a genus of the order *Diptera* and family *Syrphidæ*. The two basal joints of the abdomen are long and slender, with the remaining joints depressed and broad; they are of bronze-colour marked with yellow, and are found upon flowers in the neighbourhood of London.

Bacchanalia (Lat.). Festivals in honour of Bacchus. Such legends as those of Lycurgus and of Pentheus indicate the opposition made to the introduction of these festivals, which were imported from eastern countries. (Grote's *History of Greece*, i. p. 38, &c.) They consisted originally of a grand procession, in which the priests and priestesses of Bacchus bore the principal part, and were accompanied with games, spectacles, and theatrical representations. But, at a later period of Grecian history, vice, debauchery, and licentiousness became their distinguishing characteristics; and Plato (*De Leg.* l. i.) asserts that during the celebration of these festivals he has seen the whole Athenian populace in a state of drunkenness. At Athens, there were two principal Bacchanalia held annually: viz. Dionysia or Majora, celebrated in the city about spring time; and Lenæa or Minora (so called from ληνός, a winepress), celebrated in the country during autumn. On these occasions, the Bacchæ or priestesses of the god ran up and down the mountains in a frantic manner (Stat. *Theb.* vi. 92), clad in doe-skins, with spears in their hands, bound at the points with ivy-leaves (thyrsi), and using the wildest gestures and exclamations. (See the *Bacchæ* of Euripides.)

These festivals were introduced from Greece into Etruria, and thence by an easy transfer into Rome, where they were at first celebrated chiefly by young men on their laying aside the toga prætexta for the toga virilis. But they soon after extended among all classes of the community; and the crimes practised at their celebration became so great, that the senate (A.U.C. 566) came to the resolution of abolishing them entirely. (Cicero, *De Legibus*, ii. 15.) But the Liberalia, a more harmless festival, still continued to be celebrated yearly in March. (Ovid, *Fast.* iii. 713.)

Bacchus (Lat.; Gr. Βάκχος, or Ἴακχος, perhaps from ἰάχω, *I shout*). This name, arising probably from the cries which accompanied his worship, was adopted by the Latins to signify the god commonly known to the Greeks as Dionysus [which see].

Bachelor. In the English universities, the lowest degree in arts, law, divinity, medicine, and music. It is, like other university honours, of French origin. For the various derivations that have been suggested for this word, see BACCALAUREAT.

BACHELOR. In Heraldry, the lowest order of knighthood. [KNIGHT.]

BACHELOR. In some of the Livery Companies of London, is one who is not yet admitted of the livery; also called *yeoman*.

Bacillareæ. A small group of diatomaceous *Algæ*, having an extremely simple structure, and in part the same as what are called *Cymbelleæ*. They stand on the limits of the animal and vegetable kingdoms, and are said to have a power of spontaneous motion.

Bacillus (Lat.). A name given to the cotyledon of the hyacinth by Link. The little bulbs found on the inflorescence of some plants.

Back. A reservoir or cistern. The *liquor back* in a brewery is the water reservoir.

Back and Fill. To keep a ship in the middle of the stream of a narrow river, by alternately advancing ahead from one shore and moving backwards from the opposite shore, while the stream carries her along, the wind being contrary to the direction of the stream.

Back (from the Sax. bæc) **of a Hip.** In Architecture, the upper faces of the hip rafter between the two sides of a hipped roof, so formed to an angle as to be in the same plane with the rafters on each side of it.

Back the Oars. To row the oars backwards.

Backer. In Architecture, a term used to denote a narrow slate laid on the back of a broad square-headed slate, where the slates begin to diminish in width.

Backgammon. A game played with dice by two persons on a table divided into two parts, upon which there are 12 black and as many white spaces, called *points*. Each player has 15 men, black and white, to distinguish them. This game is of Welsh origin, and is said to have been invented in the period preceding the Conquest. (*Gloss. ad Leges Wallic.* cited by Henry, vol. iv. p. 404.) In backgammon, though much depends on chance, still great skill may be displayed in the course of the game. Hoyle, the received oracle in these matters, has evinced great accuracy in calculating the odds of backgammon, and has embodied a variety of useful rules and instructions respecting it.

Back-staff. An instrument used before the invention of the quadrant and sextant, for taking the sun's altitude at sea. In using it the observer turned his back to the sun, whence the instrument had its name. It was invented by Captain John Davis, about the year 1590, and is now obsolete.

Back-stays. In Sea language, ropes stretched from the topmast, top-gallant mast, and royal-mast heads to the starboard and

port sides of the ship; their use being to support the masts, and second the efforts of the shrouds. [RIGGING.]

Baconian Philosophy. The system propounded by Francis Bacon, Lord Verulam. It is usual to speak of this philosophy as if it were the invention of its illustrious founder—as if the method of induction were a mode of philosophising unknown before his time, and in direct opposition to preceding systems, especially that of Aristotle; this opinion is erroneous. Aristotle has in many parts of his works clearly and satisfactorily explained the inductive method, and has himself, in his physical writings, given examples of its application. Lord Bacon's distinguishing merit consists rather in the attention which, by his splendid eloquence, his wonderful power of illustration, his comprehensive views of the relations of the sciences to each other, and his unhesitating faith in the boundless progressiveness of human knowledge, he succeeded in awakening in the minds of his countrymen, than in any philosophical discoveries properly so called. No man, we admit, ever obtained a clearer insight into the nature and province of inductive research; no man, certainly, has laid down with such rigour and accuracy the rules for its successful prosecution. The various modes of experimenting and observing (in the language of Bacon *instances*) are classed under twenty-seven heads; and the circumstances under which each kind is applicable are stated with great fulness and accuracy. This is done in the second book of his *Novum Organon*, the first consisting of aphorisms on the errors of the human intellect generally, and in particular of preceding philosophical systems. These delusions, under the name of idols, he reduces to four classes: the *idols of the tribe*, or those common to human nature generally; the *idols of the cave*, or those generated by individual peculiarities; the *idols of the market-place*, produced by the incorrect use of words in ordinary discourse; and lastly, the superstitions introduced by false and visionary systems of philosophy, to which the name is assigned of the *idols of the theatre*. His own method he designates as holding an intermediate place between the merely empirical and the dogmatical schools. 'While the one,' says he, 'like ants, content themselves with heaping up materials for immediate use, the latter, after the manner of spiders, spin webs out of their own brain: there is a middle and a better way—that of the bee, which derives, indeed, its material from the flowers of the garden and the field, but converts and digests it by its own proper virtue.' These two books of the *Organon* form the second great division of his projected undertaking, the *Instauratio Magna*, or *Reform of Philosophy*, and relate to the interpretation of nature. The treatise *De Augmentis Scientiarum* (*Of the Advancement of Learning*) constitutes the first division: the third was to consist of a history of the phenomena of the universe: the fourth (*Scala Intellectus*) was to comprise an account of the processes of the human understanding, with examples from various sciences: in the fifth was to be contained the introduction to the *Philosophia Secunda*, or *Active Philosophy*, which, as the combined result of history and experience, was itself to constitute the sixth and last division. (See his *Distributio Operis*; Bacon, *Works*, 4to ed. vol. iv.) Of this mighty work Bacon only completed the first two divisions. For a comprehensive and impartial estimate of the value of the Baconian philosophy, the German scholar may consult Tennemann's *Geschichte der Philosophie*, 10ter band (Leipzig, 1817), Stewart and Playfair, *Preliminary Dissertations* (*Encyclopædia Britannica*), and the elaborate edition of Bacon, by Spedding, Ellis, and Heath, now in progress (1862).

Bactris (Gr. *βάκτρον, a cane*). A genus of palms with spiny slender stems and pinnated leaves. Their fruit is succulent, and manufactured into a kind of wine. Walking sticks, made from their stems, are known as Tobago canes.

Baculites (Lat. baculus, *a stick*). A genus of fossil Tetrabranchiate Cephalopods, the chambered shells of which are quite straight, but differ from those of the Orthoceratites in having sinuous or undulated partitions with lobated margins: in this structure they are allied to the Ammonites.

Badger. [MELES.]

Badister (Gr. *βαδιστής, a walker*). In Entomology, a genus of the order *Coleoptera*, and family *Harpalidæ*. This genus, with some others, forms a leading group among the carnivorous beetles.

Bagasse (Fr.). The sugar-cane in its dry crushed state, as used for fuel in the colonial sugar-houses.

Baggage (Fr. bagage). In Military language, the clothes, tents, provisions, and other necessaries belonging to an army.

Bagging. In Agriculture, a mode of reaping corn or pulse with a hook, in which the operator effects his object by striking the straw or haulm, instead of drawing the hook through it. In other words, it is separating the straw or haulm from the root by chopping, instead of by a drawing cut.

Bagpipe. This instrument appears to be of very ancient origin, and is similar to the *tibia utricularia* described by Blanchinus. A representation of it is given by Luscinius in his *Musurgia* (1536), whence it appears that at that time the instrument was similar to that now in use. It consists of a leather bag, inflated through a valved tube by the mouth (or a bellows), and of three pipes; two of which give only one note each, and are called the great and little drone; and the third, somewhat like the oboe, has eight finger-holes. The small Irish bagpipe is a much less powerful instrument than the great Highland bagpipe, still used, but chiefly at dances, in the Highlands of Scotland. In the southern parts of Italy, especially in Calabria, the bagpipe is still a common instrument. And some passages

in *Don Quixote* prove that it was used in Spain down to the time of Cervantes.

Bagrationite. A variety of Allanite, named after Count Bagration.

Bagshot Sands. The beds thus named belong to the middle Eocene group of tertiaries as now determined in England. The upper division of the Bagshot sands is thick, and agrees either with the lower Barton clay sands or with the upper Bracklesham beds. The middle division corresponds with the Bracklesham series and Barton clay, but is thin and very fossiliferous, the lower division distinctly underlies the Bracklesham series, and forms the base of the middle Eocene series. These sands are developed on Bagshot Heath.

Baierine (Ger. Baiern, *Bavaria*). The name given by Damour to a variety of Columbite found in Bavaria.

Baikalite. A crystalline variety of Sahlite found in Siberia at the mouth of the Sljumanka river, which falls into Lake Baikal.

Bail (Old Fr. bailler, *to deliver or give up*, said by Dufresne to be derived from Lat. bajulus, *a bearer*, a derivation adopted by Mr. Wedgwood, *Dictionary of English Etymology*). In Law, is the liberation of one in custody, whether for a civil or criminal cause, on surety taken for his appearance at a day and place certain. In civil cases bail is chiefly of two kinds, called bail to the sheriff, and bail to the action; or, in other terms, bail above and bail below. When a person is arrested upon an affidavit made that he is indebted to the plaintiff in the sum of 20*l*. or upwards (which, since the Act 1 & 2 Vict. c. 10, must also state that there is probable cause for believing that the defendant is about to quit England), he has then, in order to regain his liberty (unless previously discharged under a judge's order), to execute a bail bond to the sheriff, the condition of which is, that he will at the proper period put in special bail, which amounts to an appearance in court; at this period he either puts in special bail, who are two or more persons, who undertake generally that if the defendant lose the verdict he shall pay the amount awarded against him, or render himself to custody, or that they will do it for him. In default of special bail he returns again into custody.

Bail, in cases of felony, is taken by committing magistrates at their discretion in cases where the evidence against the prisoner is not such as to raise a strong presumption of his guilt; in cases of misdemeanour, except such as are enumerated by the Act 11 & 12 Vict. c. 42, the magistrates are bound to take bail.

Bail-bond. In Law, is a deed executed by a party arrested formally on mesne process, or a debtor arrested as about to abscond, 14 & 15 Vict. c. 52, and two persons as his sureties, to the sheriff, conditioned for his causing special bail to be put in. If the defendant neglect afterwards to put in and perfect such bail, the plaintiff usually takes from the sheriff an assignment of the bail-bond, and proceeds against the defendant in a separate action.

Baillie. The name by which the municipal magistrates of Scotland are designated. The term is synonymous with *alderman*.

Bailiff (Fr. bailli). Properly, anyone to whom authority is entrusted: whence it came to signify more generally 'deputy,' and was applied to those officers who, by virtue of deputation either from the sheriff or the lords of private jurisdictions, exercised within the hundred, or whatever might be the limits of their bailiwick, certain judicial and ministerial functions. With the disuse of private and local jurisdictions, the meaning of the term became commonly restricted to such persons as were deputed by the sheriff to assist him in the merely ministerial portion of his duty, such as the summoning of juries and the execution of writs. These persons are called bound bailiffs, so termed from the obligation which they enter into to indemnify the sheriff against the consequences of his responsibility for their right conduct in the discharge of their duty.

Bailiwick (Fr. bailli, and Lat. vicus, *a village*). The dwelling-place or district within which a bailiff exercises his deputed authority: thus, a county is said to be the bailiwick of the sheriff.

Bailment. In Law, is a delivery of goods in trust, upon a contract, express or implied, that the trust shall be faithfully executed on the part of the bailee, or receiver. Transactions with carriers, agents, pawnbrokers, and many other mercantile proceedings are affected by the law of bailment.

Bairam. A Mohammedan feast, instituted in imitation of the Easter of the Christian church, and following the Rhamadan, or month of fasting, which answers to our Lent. In consequence of the Turkish mode of reckoning by lunar months, these periods fall successively in all the seasons during a cycle of thirty-three years. Sixty days after the greater follows a second feast, termed the lesser Bairam.

Bajaderes. This name, which is supposed to be a corruption of the Portuguese *bailadeira*, is applied to the Indian dancing girls, who, under various appellations, are employed partly as priestesses, partly by the grandees of India to cheer their festivities and minister to their pleasure. Their dress consists of costly materials, tastefully arranged, and their movements are graceful. In their whole character and proceedings, they bear a strong resemblance to the *Hierodoulai* of the Greeks.

Bajulus (Lat.). An officer of the Roman emperors, in the court of Constantinople, to whom the education of a prince was entrusted. There were several grades of Bajuli.

Balæna (Lat.; Gr. φάλαινα). The Greenland whale; also a generic term, comprehending the species which agree with it in the presence of whalebone in the mouth, and the absence of a dorsal fin.

It is to this genus that the whale, properly so called, or large-whalebone whale (*Balæna mysticetus*, Linn.), belongs, the value of which is such that large fleets are fitted out expressly

for its capture. The food of the whale consists of small molluscous and crustaceous animals, but chiefly the *Clio borealis*; and as these animals abound only in the Arctic seas, the whale cannot be expected to frequent for any length of time those latitudes in which its food is scarce or altogether wanting. The long-continued annual destruction of the *Balæna mysticetus* has greatly diminished the numbers of this species, and driven those which remain to the extremest limits of the northern seas where their means of subsistence can be obtained.

The large-whalebone whale is often spoken of as the largest of existing animals, but it is inferior in magnitude to the so-called small-whalebone whale (*Balænoptera*). The latter attains the length of from ninety to a hundred feet; while the ordinary dimensions of the true whale are from fifty to sixty feet in length, and from thirty to forty feet in circumference. The terms 'large whalebone' and 'small whalebone' relate to the size of the whalebone or baleen-plates, which is always much greater in the genus *Balæna* than in *Balænoptera*; and it is this structure, combined with the greater amount of blubber in the true whale, which renders it an object of so much more value to the whale-catchers; while its less courageous habits, and less violent efforts to escape when wounded, make it a more sure and safe prey than the small-whalebone whale.

The true whale is chiefly remarkable for the immense size of its head, which constitutes a full third of the entire length of the animal: it is narrow above, but very broad below, where it consists chiefly of a large under-lip, which rises five or six feet, and completely overlaps the upper lip: the eyes are very small and are placed just above the angles of the mouth. The external opening of the ears is scarcely perceptible. The pectoral fins are of moderate size, and placed about two feet behind the angles of the mouth. The neck is indicated by some furrowing of the skin, but there is no constriction. The greatest circumference of the cylindrical body is a little behind the pectoral fins. The tail-fin consists of two lobes of great breadth, measuring twenty feet across from tip to tip in a full-grown specimen; and wielded by muscles of enormous power. It is this part which constitutes the sole organ of offence and defence in the whale, for it has no teeth wherewith to bite or lacerate; a single blow of the tail well delivered suffices to cut a stout boat in two, or to send it whirling through the air.

The plates of whalebone are the substitutes for teeth in the mouth; they have a similar mode of developement from a pulp and external membrane, and differ only in form, and in a less proportion of earthy matter in their composition. They are arranged vertically and transversely, in two series, consisting each of three hundred plates, descending from the palatal surface of the upper jaw, and terminating in a fringe of coarse hairs on their oblique lower and inner margins, which hairs are in contact with the upper surface of the bulky tongue when the mouth is closed. It is thus that the mechanism of the sieve is realised on an enormous scale; and while the water gulped at each successive mouthful is drained off through the interstices of the baleen plates, the molluscous and crustaceous animals are retained bruised into a pulp between the muscular tongue and coarse fibres of the whalebone, and swallowed. The area of the gullet corresponds with the minute character of the food, and is relatively smaller in the whale than in any other animal. The stomach is divided into four cavities; the intestinal canal is long and narrow, and provided with a short and simple cæcum.

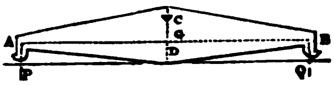
The whale has usually but one young at a birth, and brings forth in the early spring. The period of gestation is unknown; that of suckling lasts a year. In this stage of their growth the young are called *short heads* by the whale-fishers; at two years old, and until they are able to find their appropriate food in due abundance, they are termed *stunts*; when they begin to get fat, and until they have arrived at their full size, they are called *skull-fish*.

The interesting details of the profitable but perilous occupation of whale-fishing will be found most amply and correctly given in Scoresby's *Account of the Arctic Regions*, from which many popular narratives have been compiled. The baleen and the blubber are the only parts of the animal of any commercial value, and the quantity of both yielded by these enormous animals is of course considerable. The length of the largest whalebone plates in a whale of sixty feet is as much as twelve feet; and the blubber of such a one will yield more than twenty tuns of pure oil, the proportion of oil to the blubber from which it is extracted being as three to four. The blubber is principally accumulated at the circumference of the body, beneath and in the extended tissue of the skin; an immense quantity of fine oil is also lodged in the cellular substance of the tongue; and the coarse and porous bones, particularly the lower jaw, are full of oil.

Balæniceps. A remarkable bird, which has been described by the accomplished ornithologist Mr. John Gould, from the upper part of the White Nile in Eastern Africa. Its bill, much longer than the head, is robust and broad, and terminates in a powerful hook; the tip of the lower mandible is truncated. The wings are very powerful.

Balance (Lat. bilanx, from bis, and lanx, *a dish*, i. e. an instrument with two scales, hanging from a beam). A machine for weighing substances. The process of weighing may be performed in various ways, and accordingly there are several kinds of balances; as the common balance or scales, the bent-lever balance, the spring balance, the steelyard, the hydrostatic balance, &c. [for which see the respective words]. The term is also applied to any apparatus employed for comparing the intensities of very small forces, as the electric balance, the balance of torsion, &c.

Neglecting the mere circumstance of construction, and the particular methods of suspension, the balance may be represented thus:—



A and B are the points from which the scales are suspended at the extremities of the beam, C the point of support, G the centre of gravity of the beam, D the point in which the straight line C G intersects the straight line joining A and B.

The properties required in a good balance are *sensitiveness* and *stability*. The balance must be sensitive; that is to say, when it is properly poised a very small addition of weight to either scale should disturb the equilibrium, and cause the beam to turn; and it must be stable, that is to say, when the equilibrium has been disturbed the beam should quickly return, and oscillate about the position of rest.

In the construction of a good balance it is of importance that the beam be as light as possible consistent with inflexibility; for not only the inertia, but also the friction, is increased in proportion to the weight, and the sensibility consequently diminished. A cylinder of steel, passing through the centre of the beam at right angles, forms the axis; and its extremities, ground into sharp edges on the lower side, serve as the points of support. The two edges must be accurately in the same straight line, and turn on smooth planes of agate or polished steel carefully levelled. The scales should likewise be suspended from the extremities of the beam by agate planes resting on knife edges. A needle, or tongue, is usually attached to the beam, pointing directly upwards, or downwards, when the beam is horizontal, for the purpose of indicating the deviations of the beam from the horizontal position, on a graduated scale. It is better, however, to bring the arms to terminate in points, and to place a divided scale behind each; in this way the slightest deviation of the beam will be rendered evident, if the zeros of the scales are placed exactly in the same level. The scale is indispensably necessary, because the balance, if very sensitive, would require a long time to come to rest; but it is known to be poised, when the excursions of the needle on both sides of the zero of the scale are equal. In order to preserve the knife edges, the beam, when not in use, is supported on rests. Props should also be placed under the scales while loading or unloading the balance. The whole apparatus must be placed under a glass case, to protect it from the disturbing influence of currents of air.

The sensitiveness of a balance constructed with due care, according to the principles now explained, may be carried to an almost inconceivable extent. Analytical balances are usually made to carry 1000 grains in each pan, and to turn with the $\frac{1}{1000}$th part of a grain.

There are several large balances in use at the Royal Mint, calculated to weigh from 1,000 to 5,000 ounces troy; some of them are of excellent construction, turning, for instance, with one-tenth of a grain, when loaded with 1,000 ounces in each scale, or with one nine-millionth part of the weight.

Chinese Balance. This is formed of a slender tapering rod of wood or ivory, about a foot in length. A silk thread passed through a hole perforated nearer one of its extremities than the other serves as the point of suspension. The balance has thus two unequal arms. From the extremity of the shorter a small scale is suspended to hold the substance to be weighed. A sliding weight passes along the other arm, on which divisions are marked; and when the counterpoise is made, the distance of the standard weight from the fulcrum indicates the weight of the substance. In order to procure a greater range, the rod has generally four holes or points of support, at different distances from the extremity, and a corresponding set of divisions is marked on each of its four sides. The principle of this machine is exactly the same as that of the common steelyard.

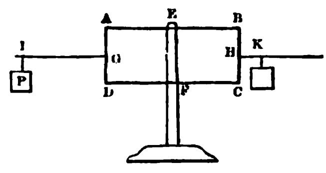
The *Danish Balance*, much used in the north of Europe for weighing coarse commodities, is usually formed of an iron bar, or a batten of hard wood, having a lump of lead at one of its extremities. The goods are fixed in a hook at the other end; and the whole is suspended through a loop of cord, which is passed backwards and forwards under the rod till equilibrium is obtained. The weight of the goods is then to the weight of the lead reciprocally as their respective distances from the loop.

Balance, Automatic. [COIN-WEIGHING MACHINE.]

Balance of Power. In Politics, a system by which the relative power of different states and alliances is so maintained as to render any extensive derangement improbable. The idea of preserving a balance of power naturally suggested itself to statesmen in ancient Greece, where so large a number of independent states with opposing interests existed on a narrow territory. In Europe, this portion of political science scarcely began to be understood until the sixteenth century; since which time the maintenance of the balance of power has formed a favourite object, often pursued with unreasonable avidity, by those who have controlled the international relations of Christendom. The great aim of neutral politicians during that century was to establish a balance between the power of France and that of Austria: the latter, united with that of Spain, was so great as to cause much anxiety. But after the commencement of the seventeenth century the power of France steadily increased, and that of Austria abated. Cromwell's alliance with Mazarin was the last result of the ancient system: for the alliances of Charles II. with the French were for personal objects, and were strongly reprobated by all European statesmen. At the end of the seventeenth century France stood predominant, and it became the great problem of

European politics to find a counterpoise to her influence. This was the aim of William III., Eugene, and the Whigs under Queen Anne; and the treaty of Utrecht in 1713, which acknowledged the French supremacy in Spain, was condemned as one of the severest blows ever struck at the balance of power. Nevertheless, this fear, like so many others sedulously cherished by speculative statesmen, proved to have little foundation. The power of France remained stationary during the eighteenth century, while the forces of Austria, Russia, and Britain increased; and Prussia suddenly arose, from a third-rate Power, to the lowest, but still a respectable position, among the first-rates. During that century the alliances were formed with no very steady regard to the balance of power: France and Austria were usually, but not uniformly, rivals. In 1756, the three great Continental Powers were united in a fruitless endeavour to crush the new state of Prussia. The wars of the French revolution entirely altered the ancient equilibrium; it was restored by the congress of Vienna; and the long maintenance of that peaceful arrangement certainly speaks in favour of the sagacity of its constructors. At present Europe is divided, singularly enough, by two different sets of causes, producing different alliances, or rather tendencies towards alliances, for mutual defence. From 1830 to 1850 it was supposed that the opposition between despotic and constitutional principles would range on the one side, Austria, Russia, and Prussia; on the other, England, France, Belgium, Holland, and the other states which enjoy constitutional governments. But since the establishment of the French empire of 1852, new combinations have arisen, the issue of which it is impossible to predict. The modern policy of non-intervention must also have its influence in modifying the old theory.

Balance of Roberval. A mechanical paradox devised by the French mathematician Roberval, in the seventeenth century. The instrument still deserves a place on the lecture-table, since it illustrates in a striking manner the mechanical theory of couples. It consists of a parallelogram, A B C D, whose opposite sides, A B and C D, turn around two fixed points, E and F, at their centres. From the



other pair of opposite sides, A D and B C, project two fixed bars, G I and H K. The paradox consists in the fact that two *equal* weights, P and Q, will hold each other in equilibrium no matter from what points of these bars G I, H K, they may be suspended. Poinsot, the inventor of the theory of couples, was the first to give a really scientific explanation of the paradox (see his *Élements de Statique*). A description of Roberval's balance is given in the *Mémoires de l'Acad. Roy. des Sciences*, t. x. p. 494 (Paris, 1730).

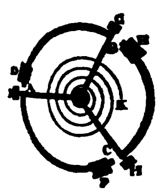
Balance, Roman, or **Steelyard.** [STEELYARD.]

Balance of Torsion. A machine invented by Coulomb for measuring the intensities of electric or magnetic forces, by establishing an equilibrium between them and the force of torsion. Conceive a metallic wire suspended from a fixed point, and kept stretched by a small weight attached to its lower extremity; where also a horizontal needle or lever is fixed, which may be rendered magnetic, or is so formed that one of its ends is a conductor and the other a non-conductor of electricity. The force is brought to act on the extremity of this lever, and its intensity measured by the length of the arc which the needle passes over, reckoning from the point of repose; or an index may be attached to the upper extremity of the wire, and the force measured by the number of degrees through which it can be turned before the lower lever begins to move. The force of torsion is inversely proportional to the length of the wire, and directly to the fourth power of its diameter. The wire must therefore be of considerable length (two or three feet for example), and very fine; and also formed of a substance possessing considerable elasticity. Brass wire is greatly preferable to iron wire; and in some instruments recently constructed a fine thread of spun glass has been used instead of metallic wires, at the suggestion of the late Professor Ritchie. One of the most interesting applications of the torsion-balance was that made by Cavendish to measure the force of attraction of two leaden spheres, in his celebrated experiment to determine the mean density of the earth.

Balance of Trade. The term commonly used to express the difference between the value of the exports from and the imports into a country. The balance is said to be favourable when the value of the exports exceeds that of the imports, and unfavourable when the value of the imports exceeds that of the exports. The notion was once entertained that the prosperity of a country depended on exporting merchandise exceeding the value of the imports, and receiving the balance in the precious metals. This mode of estimating the balance of trade, which is evidently founded on the assumption that the precious metals constitute the wealth of a country, has been proved to be completely fallacious, and it is now conceded on all hands that gold and silver are nothing but commodities, whose exportation or importation it is necessary neither to prevent nor encourage by any legislative enactments. But the theory of the balance of trade is not erroneous merely from the false notions which its advocates entertain with respect to money: it proceeds on radically mistaken views as to the nature of commerce. For it will be found that, so far from an excess of exports

over imports being any criterion of an advantageous commerce, it is directly the reverse; since, were the value of the exports greater than the value of the imports, merchants would lose on every transaction with foreigners, and the trade with them would be speedily abandoned. For a succinct statement and exposition of the errors which were till lately generally prevalent upon this subject, see M'Culloch's *Commercial Dictionary*.

Balance of a Watch. That part of the machine which, by its inertia, regulates the beat and produces equable motion. It is formed of a wheel or ring, having its weight principally accumulated in its rim, and connected with a spiral spring in such a manner that when drawn aside from the position of rest it acquires an oscillatory motion from the alternate contraction and expansion of the spring. The balance answers the same purpose in watchwork as the pendulum in clockwork, and is affected in a similar manner by variations of temperature. Supposing the length of the spring to remain constant, the time of vibration is directly proportional to the distance of the centre of gyration from the axis of the balance; consequently the duration of the vibration is increased by heat and diminished by cold. To remedy this inconvenience, various contrivances have been applied; but that which is most generally adopted is the *expansion* or *compensation balance*, the principle of which depends on the unequal expansion of two different metals. It may be constructed in the following manner:



The rim consists of two laminæ, the inner of steel and the outer of brass, united by fusion. After being turned to the proper size, the rim is cut in three places, A, B, and C; and one end of each of the parts thus formed being fixed to an arm of the balance, the other is left at liberty to move inwards or outwards according to the variation of the relative lengths of the two metals. D, E, F, are three equal weights placed near the free ends, and which, when adjusted at the proper distances, are fixed in their places by means of screws. Three heavy-headed screws, G, H, I, enter the arms of the balance, and serve to adjust its centre of gravity to the axis of vibration, and also to increase or diminish the mean rate of motion. Now, suppose the balance to receive an increase of temperature, this will tend to lengthen the arms, and consequently to throw the centre of gyration further from the axis, and thereby diminish the velocity of vibration; but as the brass expands more than the steel, the compound bars will at the same time be bent inwards, and the weights D, E, F thereby thrown nearer the axis, by which the velocity will be increased. When the temperature is diminished, the arms are shortened; but the weights are now thrown to a greater distance from the axis by reason of the contraction of the brass being greater than that of the steel, and the consequent tendency of the compound bars to assume a less curved form. It is obvious that in so small a machine the adjustment of the parts to procure exact compensation is a matter of great nicety, and requiring much practical skill.

Balaninus (Lat.). In Entomology, the name applied by Germar to the subgenus of Weevils (*Curculionidæ*), of which the nut grub or nut weevil (*Balaninus nucum*) is a species. In the perfect insect the rostrum or borer is nearly as long as the body. It is by means of this instrument that the parent weevil drills a hole through the soft shell of the immature filbert, into which she introduces a single brown egg; this is hatched in about a fortnight, and by the time the nut is full ripe, the grub has attained its full growth; it then proceeds to bore a hole with its jaws through the shell, and emerges from the cavity of the nut; falling to the ground it burrows into the earth, and there remains during the winter, changing to the proper state, and appearing as a perfect insect in August.

Balanites (Lat. balanus, *an acorn*). In Zoology, acorn-barnacles; an order of Cirripeds, comprehending those which have a shelly tube, adherent by its base to foreign substances, and closed at its apex by four opercular valves.

Balanophoraceæ (*Balanophora*, one of the genera). A natural order of Rhizanths found mostly in hot climates, and consisting of fungus-like parasitical plants, with small monœcious flowers, collected in dense heads arranged upon fleshy receptacles.

Balas Ruby. The name given by lapidaries to the rose-red varieties of Spinel.

Balausta (Gr. βαλαύστιον, *the wild pomegranate flower*). In Botany, a kind of fruit having a leathery rind, a superior calyx, and several cells irregularly disposed, with many drupaceous seeds in each, as in the pomegranate.

Balcony (Ital. balcone). In Architecture, a projection from the external or internal wall of a house, borne by columns or consoles, usually placed before windows or openings. Balconies sometimes form a kind of string, and are continued from end to end of the building.

Baldachino (Ital. *a canopy*). In Architecture, a species of canopy over the principal altar of a church similar to that at St. Peter's, where it is supported by columns; or that of St. Sulpice at Paris, where it is suspended from above. It succeeded to the ancient *ciborium* [see that word], which was a cupola supported on four columns, still to be seen at many of the altars in Rome. Bernini may claim the merit of its invention. The height of that which he erected in St. Peter's is 128 feet, and being entirely of bronze weighs near 90 tons. It was built by order of the Pope Barberini, from the robbery of the roof of the Pantheon, and occasioned the bitter sarcasm—'Quod non fecerunt Barbari, fecerunt Barberini.'

Baldric (Low Lat. baldrellus). A girdle used by the warriors of feudal times; it was often splendidly ornamented, and marked the rank of the wearer.

Baldwin's Phosphorus. Fused nitrate of lime, which, after having been exposed to light, appears luminous in a dark place.

Balearic Crane. [CRANE.]

Baleen (Fr. baleine). The term for whalebone in common use among whale-fishers.

Ball. Literally, anything made in a globular form. The word signifies also at once a well-known *divertissement*, and a game familiar in Europe and America. Ball-playing was a favourite amusement among the ancients, who practised it in various ways. They had their hand-ball (*pila trigonalis*), played by three persons standing in the form of a triangle, their foot-ball (*follis*), and some other kinds not used by the moderns. Every complete gymnasium had its *Sphæristerium*, or place set apart for the game, with a master specially for teaching it, as long practice and great skill were necessary for it. In the middle ages there were houses appropriated to ball-playing; and in Italy there are still public places where this amusement is practised, and great dexterity displayed.

BALL. In the art Military, any round substance of iron or lead discharged from fire-arms, as cannon or musket balls. When artillery was first invented, cannon balls were rudely cut from blocks of stone; they are now made mostly of cast iron, and musket balls of lead. From the increasing use of rifled guns and rifled small arms, round projectiles are being superseded to a great extent, though they have still many advocates, who prefer them to elongated projectiles against armour plates.

Ballad (Ital. ballata, Fr. ballade). A species of narrative poetry, founded either on history or fiction, displaying the condition and the habits, the tastes and the sentiments of the various nations among whom it is found. The term ballad is very indefinite in its general acceptation, including classes of composition wholly different in themselves, of which the only common characteristics are brevity of metre and simplicity and perspicuity of style. While some authors have assigned to the ballad an Arabian, some an Armorican origin, and others have claimed this distinction for the Normans and Provençals, Percy, Bouterweck, and Schlegel concur in awarding to it a Teutonic descent. It is, however, agreed that the Scandinavian nations delighted at a very early period to celebrate in song the deeds of heroes, lovers, knights, &c.; and the three great divisions of the Teutonic poetry of the middle ages—the stories of the Nibelungen, those of Charlemagne (particularly such as relate to his wars against the Arabians and the battle of Roncesvalles), and the tales of King Arthur's Round Table, consist of what at a later period were called Ballads. Though the name Ballad is Italian, the spirit of chivalry had at no period during the middle ages much dominion or influence on the other side of the Alps: a circumstance which sufficiently accounts for the meagreness of the Italians in this department of poetry. The French too never attained any perfection in the ballad, as their fabliaux, legends, &c. soon degenerated into long prose romances, which were quite destitute of the spirit of the ancient minstrelsy. The Spaniards, on the other hand, are rich in ballads of a highly chivalrous character. These, however, along with some Portuguese ballads which bear clear marks of a Spanish origin, may with more propriety be classified under the denomination of Romantic Poetry. Among the Welsh even so early as the twelfth century, music and this species of poetry seem to have attained a high degree of excellence; but of all the species of ballad, the Irish, among other characteristics, appears to be pre-eminently fitted for adaptation to music, as is witnessed in the universally admired *National Melodies* of Thomas Moore. While there is much difference of opinion among the learned as to the nature and requisites of the ballad, it is admitted on all sides that England and Scotland possess a collection of ballads superior to those of every other nation. The home of the English and Scottish ballads is either in the north of England, or in the southern counties of Scotland, as there the influence of the Normans was less than in the south of England. To the proximity, also, of those parts of the two countries where the ballad was cultivated, and the small circle which they embraced, may be attributed the difficulty that exists in assigning to each country its proper share in the collection of ballads. In modern times, if we except the romantic legends of Sir Walter Scott (which can scarcely be denominated ballads), the Germans have cultivated this species of poetry with more success than any other nation; and they can boast of Schiller, Goethe, and Bürger, not only as distinguished poets, but as the revivers of that chivalrous spirit which formed the grand characteristic of our British ancestors. For remarks on the Ballad, see Aikin, *History of Song*; Warton, *History of English Poetry*; Burney, *History of Music*; Motherwell, *Ancient and Modern Minstrelsy*; Jones, *Musical and Poetical Relics*; Schlegel, *Kritische Schriften* (article on Bürger); Sir W. Scott, *Minstrelsy of the Scottish Border*; Bishop Percy, *Reliques of Ancient English Poetry*.

Ballast (a word of uncertain derivation). Is a mass of weighty material placed in the bottom of a ship or vessel, to give her *stiffness*; that is, to increase her tendency to return to the upright position when inclined or *heeled over* by the force of the wind or other cause. Ballast consists of shingle (the coarse gravel of the sea-beach), stones, &c. In the Royal Navy iron ballast alone is used, in pigs of nearly 3 cwt. This has the advantage of lying in small compass; but in consequence of its great weight it tends to give excess of stability, which renders the vessel *uneasy* from the

suddenness of the motion: this defect is remedied by *winging* up the ballast, whereby its centre of gravity is raised. For the like reason, in stowing the ballast it is tapered to a point at the fore and aft extremities. Iron ballast, from its greater cleanliness, is more healthy for the crew than that of other materials. When a ship has no other loading, she is said to be *in ballast*.

The quantity of ballast and the mode of its stowage differ greatly in different vessels; and the connection between the motions of a ship and her stowage has not yet been analysed sufficiently to lead to the discovery of direct rules on these important points.

Ballet (Fr.). A theatrical representation of actions, characters, sentiments, and passions, by means of mimic movements and dances, accompanied by music. The ballet is divided into three kinds—historical, mythological, and allegorical; and consists of three parts—the entry, the figure, and the retreat. (Noverre, *Lettres sur les Arts imitateurs, et sur la Danse en particulier.*) The chief merit of the ballet lies in an ingenious adaptation of music to the sentiments of the mind as developed in the dance, and in its power of representing every variety of human conduct and emotion, whether of a tragic or comic nature. The art of dancing to music, called *ὄρχησις*, was carried to wonderful perfection by the Greeks: but the Latin Pantomimi corresponded much more closely to the ballet-dancers of modern times. It is generally believed that Baltazarini, director of music to the Princess Catherine de Medicis, first gave its present form to the regular ballet, and that after a considerable interval it was introduced into France, and thence into Germany and England.

Ballista or **Balista** (Lat.). A Military engine, used by the ancients for throwing stones, darts, arrows, &c. The Ballista is sometimes confounded with the Catapulta; but a distinction is made by Polybius, who confines the latter term to those machines which throw stones only. The particular mechanism of these engines is not very certainly understood. According to Vitruvius they were made in divers manners; but the principle of all seems to have been the same. A beam of wood or plate of metal is firmly fixed at one extremity, while the other is drawn back by means of cords and pulleys; and being suddenly set free, the elastic force with which it seeks to recover itself propels the missiles.

Ballistic Pendulum. An instrument invented by Benjamin Robins, and first described by him in his Tracts published in 1765. It is used to determine the velocity of projectiles fired from cannon and small arms. The original instrument consisted of an iron bar, to one end of which was fixed a block of wood, the other end being attached to a horizontal bar free to move in sockets, so that the block on being struck swung together with the bar as a pendulum. A ribbon attached to the bottom of the pendulum showed, by the portion of it drawn through an orifice in the fixed framework, the length of the arc through which the pendulum moved.

The use of the pendulum depends upon the dynamical fact that if a body of small mass impinge with great velocity on a much larger body at rest, and the two bodies after impact move on together with a velocity which can be easily measured, the masses of the two bodies being given, the whole momentum after impact is known; and as this is the momentum of the smaller body before impact, the velocity with which it struck the larger body can be determined.

Robins' pendulum was improved by Hutton and Gregory, and later by MM. Piobert and Morin in France, and Major Mordecai in America. As now used, the block consists of a cast-iron case, filled with barrels or bags containing sand. It is suspended by firmly secured wrought-iron bars to a horizontal shaft which has knife edges working in Vs, so that the pendulum may vibrate freely. The arc through which the pendulum vibrates on being struck is measured on a copper arc by an index carrying a vernier. This being ascertained, the following points must be known in order to calculate the velocity of the ball on striking:—

1. The respective weights of the ball and pendulum.
2. The distance of the centres of oscillation or percussion from the axis of suspension.
3. The distance of the centre of gravity from the axis of suspension.
4. The angular velocity of the pendulum after impact.

The ballistic pendulum has been lately used in conjunction with the gun pendulum [Gun Pendulum], but is now seldom employed, the velocities of shot being more easily and correctly ascertained by Navez' electro-ballistic apparatus. [Electro-ballistic Apparatus.]

Ballium. In the Architecture of the middle ages, the open space or court of a fortified castle. This has acquired in English the appellation Bailey: thus St. Peter's in the Bailey at Oxford, and the Old Bailey in London, are so named from their connection with the sites of castles.

Balloon (Fr. ballon, *a little ball*). The name of a machine, which, consisting of an envelope containing a gas specifically lighter than common air, rises into the atmosphere with a greater or less degree of ascensional force. A car, supported by a network which extends over the balloon, supports the aëronaut; and a valve, usually placed at the top, to which a string is attached reaching to the car, gives him the power of allowing the gas to escape, and of descending at pleasure.

During the dark ages, and for some time after the revival of science, numerous projects were entertained for navigating the air; but it is only in very recent times, since 1783, that any of them have been realised. The first idea was to employ some mechanical contrivance

resembling the wings of birds; but Borelli demonstrated that all attempts on the part of man to fly must necessarily fail, from the utter disproportion of his muscular power to the force that would be necessary to give impulsion to wings of such enormous magnitude as would be required to sustain his weight in the air.

The principle by which a balloon rises in the atmosphere is exactly the same as that which causes the ascent of a cork from the bottom of a vessel filled with water. The weight of the volume of air which it displaces must exceed the weight of the balloon and all that it carries with it.

The height to which a balloon will rise is determined from the law according to which the density of the atmospheric strata diminishes as the distance from the earth is increased. The buoyant force diminishes with the density; and when it is reduced to a quantity only equal to the weight of the balloon and its appendages, no further ascension can take place. Another circumstance also confines the possible elevation within moderate limits. As the pressure of the external air is diminished, the expansive force of the confined gas becomes greater, and would ultimately overcome the resistance of any material of which a balloon can be made. A balloon quite filled at the surface of the earth would inevitably be torn to shreds at the height of a few miles in the atmosphere, unless a portion of the gas were allowed to escape. For this purpose the balloon is furnished with a safety valve, which can be opened and shut at pleasure; but to prevent unnecessary escape of gas, it ought to be made of such a size that it requires only to be partly filled.

When balloons first began to be constructed, it was expected that they would be found applicable to many important purposes. These expectations have been disappointed, chiefly because it has been found impossible to guide or control their course. The only power the aëronaut possesses over his balloon is to regulate its elevation within certain limits. In one or two instances they have been successfully used for military reconnaissance. The victory which Jourdan obtained over the Austrians at Fleurus, in 1794, was ascribed to the knowledge obtained of the enemy's movements by means of a balloon. A very interesting ascent was made by Biot and Gay Lussac, in August 1804, and by Gay Lussac alone in September of the same year, with a view to make meteorological observations in the upper strata of the atmosphere. In the first voyage, the two philosophers, at an elevation of between 9,500 and 13,000 English feet, found the oscillations of the magnetic needle to be performed in the same time as at the surface of the earth. At 12,800 feet the thermometer, which stood at 63½° at the Observatory, had sunk to 51° of Fahrenheit, being only a decrease of 1° for every thousand feet. The hygroscope indicated increased dryness in proportion to the elevation. In the second ascent, performed by Gay Lussac alone, the variation of the compass, at the height of 12,680 feet, was found to remain unaltered. At 18,000 feet the thermometer fell to the freezing point, and at 22,912 feet to 14·9° of Fahrenheit. Two flasks, which had been previously emptied of air, were opened and filled at an elevation exceeding 21,400 feet; and the air brought down from this region was found, on being analysed, to contain the same proportions of oxygen and nitrogen as at the surface. The utmost elevation which he reached was 23,040 feet, or four miles and a quarter above the level of the sea.

In the summer of 1862, Mr. Glaisher added much to our knowledge of the higher regions of the atmosphere in several ascents, undertaken at the suggestion of the British Association for the Advancement of Science, in an enormous balloon constructed and managed by Mr. Coxwell. The balloon was 55 feet in diameter and 69 feet in height, and was capable of holding 90,000 cubic feet of gas. During one of the ascents, at the height of two miles, the temperature fell to 32°, at three miles to 18°, at four miles to 8°, and at five miles to 2° below Fahrenheit's zero. At the latter height no dew was observed on Regnault's hygrometer when cooled to minus 30°. At nearly six miles, as indicated by the barometer (9¾ inches), Mr. Glaisher became insensible. Mr. Coxwell also lost the use of his hands, but had sufficient strength and presence of mind to pull the valve-string with his teeth, thus allowing of an escape of gas and the descent of the balloon. The neck of the envelope was at this time surrounded with hoar-frost. An observation made by Mr. Coxwell while Mr. Glaisher was insensible, would indicate that the greatest altitude reached was six and a half miles, and the lowest temperature 12° below zero. Of six pigeons taken up, one was thrown out of the car at three miles: it simply extended its wings and dropped like a piece of paper; the second at four miles flew downwards tolerably well; the third at four and a half miles fell rather than flew; the fourth was thrown out while descending, it flew and alighted on the top of the balloon; the fifth died before the car reached the earth; and the sixth, thrown off the finger after the aëronauts had alighted, returned to the hand, but subsequently flew away. From this ascent it would seem that five miles from the earth is nearly the limit of human existence, and that increased information which might be obtained at greater elevations is not commensurate with increased risk. One of the most important results of Mr. Glaisher's ascents is the demonstration of the fallacy of the belief that the atmosphere decreases 1° Fahrenheit in temperature for every 300 feet ascended.

Excepting in these memorable ascents, little has been gained to science by the use of balloons; and from the total failure of every scheme that has been proposed for directing their course through the air, there is little reason to anticipate any great advantages from them to society.

Ballot (Fr. ballotte). A method of voting at elections, &c., by means of little balls, of different colours, which are put secretly into a box, and, when counted, disclose the result of the poll without any discovery by whom each vote is given. In their popular assemblies the Athenians generally voted by a show of hands; but the ballot was employed where secrecy was a matter of importance. In judicial proceedings it was always used; but there were three processes, admitting different degrees of secrecy. Secret voting was also the custom of the court of Areopagus. The same system of voting prevailed also at Carthage, and to this is attributed by Ray (*Travels through Germany and Italy*) the cause of the grandeur and independence of its inhabitants. At Rome, voting by word of mouth was the practice at elections and trials, secret voting by pebbles being confined to the enactment or repeal of laws. The Lex Tabellaria of Gabinius, B.C. 139, introduced the ballot into elections of magistrates. From this period, although the practice of bribery made rapid strides, every effort was made for its suppression by the enactment of penal statutes. Since the Christian era, the ballot was adopted at a very early period by the Maltese and the Venetians. At Venice, in particular, a most curious and intricate system of voting, consisting of ten ballotations, prevailed for the space of 1,300 years; and Postellus (in a work *De Magistratibus Atheniensium*) pointedly asserts that the abolition of this practice, combined with other causes, led to the decline of this once flourishing state. Another author, after an elaborate dissertation on the advantages of the Venetian ballot, sums up his account of an election of which he had been an eye-witness in the following words: 'All was easily performed in a short time, without tumult, without noise, without animosities, and the most deserving always elected.' In our own times, as is well known, the system of voting by ballot in the election of representatives, magistrates, &c. is adopted in France and America; and, among ourselves, in cases of application for admission into private clubs and societies. Of all subjects for controversy, perhaps there is none which has excited the attention of all political parties so vividly, and furnished so large an arena for the display of argumentative skill, as the ballot.

The advocates of the ballot, on whom the onus probandi naturally rests, assume as an axiom that the great body of the electors are dependent, and consequently in an unfit condition to give a free and unbiassed vote, while the ballot, it is maintained, would not only place the elector on a footing of independence, but would remove all inducement to bribery, as no candidate would offer a bribe when the elector is at liberty to deceive him by giving a secret vote; in a word, it would annihilate the two species of corrupt influence by which electors are liable to be swayed—the influence of threats, and the influence of bribes. The opponents of the ballot, on the other hand, maintain that, even under the ballot, the canvassing of constituents by candidates would still be practised; in which case, the ballot would prove serviceable only to the dishonest elector, who promises his suffrage to one candidate and votes for another. It is further urged that even were secrecy practicable (vide Burke's *Reflections*, p. 370), it would not be desirable; for, as every elector holds his vote for the benefit of the community at large, he is bound to show by an open vote his opinion of the fitness of the candidate for his suffrage, while a secret vote is eminently calculated to lower the standard of political and moral principle, inasmuch as it removes from a public act that responsibility from which no public act ought to be exempted. And lastly, it is urged that the argument derived from the practice of France and America can have but little weight, unless it can at the same time be demonstrated that the condition of these countries in other respects is precisely analogous to that of our own. The recent history of both these countries has had a sensible effect in increasing the dislike generally felt in England for this system of voting. But, whatever may be the value of the arguments on either side, it is clear that both as Rome and Athens the people either stipulated for the adoption of the ballot in the original framing of their several constitutions, or, at soon as they ascertained the nature of their rights, insisted on its introduction, from some fancied security it afforded them in the exercise of their privileges. For some apposite remarks on the ballot, see Montesquieu, *Esprit des Lois*, ii. cap. 20; Sydney Smith, *Works*, vol. iii. 'The Ballot.'

Balneum. Was the Latin term for a bath, or the bathing vessel itself; and it was afterwards applied to a private bathing chamber. Pliny, and the more modern writers, however, use the word balneum in the sense of a private bath, and balneæ as a public bath; and they use indifferently to express the latter description of baths the terms balneæ and thermæ. It would appear from this that the public baths of the Romans were all of them supplied with warm water, and were what we should call warm baths.

Balsa (Span.). A species of float or raft, chiefly used on the coasts of South America, for landing goods through a heavy surf. The balsa is formed of two seal skins sewn up so as to form two large bags, which are covered with pitch to render them perfectly air-tight, and secured by ligatures. The bags or bladders thus prepared are inflated with air passed through a flexible tube, which is left of sufficient length to reach the mouth of the conductor, who is thus enabled to replenish them with air, should any have escaped. The two bags are fastened together at one end, which forms the prow of the vessel, the other ends being kept about four feet apart by means of a small plank; and the raft is completed with small sticks covered over with matting, having thus

the shape of a wedge or triangle. It is propelled by a double-bladed paddle, and the conductor, on approaching the shore, contrives to keep the balsa on the top of the highest wave till it is thrown on the beach to the greatest extent the surf reaches, where it is immediately secured. The balsa will carry three passengers besides the person who conducts it, and by this means cargoes are landed from merchant vessels where the violence of the surf prevents ordinary boats from passing through it without great danger. Floats of a still ruder kind, usually formed of the hides of bullocks simply stretched on a frame, are used for crossing rivers in South America, and go by the name of balsa.

Balsamaceæ. A natural order of imperfect exogenous balsamiferous trees, related to the *Platanaceæ*, now called *Altingiaceæ*. A species of the only genus, *Liquidambar*, yields the fragrant product called storax.

Balsaminaceæ (*Balsamina*, one of the genera). A natural order of polypetalous Exogens, allied to *Geraniaceæ*. They have irregular flowers, with a spur to one of the sepals; and are chiefly annual-stemmed plants, with succulent foliage and showy flowers. The common *Impatiens noli-tangere*, or Touch-me-not, is a species of this order.

Balsamodendron (Gr. *βάλσαμον*, and *δένδρον*, *a tree*). A genus of shrubby plants found in India, Arabia, and Abyssinia, belonging to the order *Amyridaceæ*. They have spiny branches, scanty pinnated leaves, and small axillary flowers succeeded by small oval drupe-like fruits. *B. Myrrha* is the reputed source of the gum-resin called myrrh; *B. gileadense* and *B. Opobalsamum* yield Balm of Gilead; *B. africana* yields African Bdellium; and *B. Roxburghii*, Indian Bdellium; and other species furnish gum-resins of similar character.

Balsams (Gr. *βάλσαμον*). Exudations from certain plants, which are liquid or soft solid, and consist of a substance resembling a resin either combined with benzoic acid or with an essential oil, or both.

Balteus (Lat.). The wide step in theatres and amphitheatres, which afforded a passage round them without disturbing the seated spectators; nobody sat upon it, but it served as a landing, or resting-place. In the Greek and the Roman theatres every eighth step was a balteus; and Vitruvius gives the rules for constructing it in the third chapter of his fifth book. The same term is used by that author to denote the strap which seems to bind the cushion of the Ionic capital.

Baltic Sea. This long narrow inland sea, of extremely irregular form, deeply indenting almost the whole of Northern Europe, receives by some 250 streams the drainage of more than a fifth part of the whole continent. It is rarely more than forty or fifty fathoms deep. It communicates with the Atlantic by a single channel, and owing to the number of rivers entering it is much less salt than the ocean. It occupies in all 135,000 square miles, its total length is 1,000 miles, and its mean breadth less than 150 miles. Beyond it the Gulf of Finland runs for 300 miles with a width of from 50 to 80 miles, and connects it with a chain of lakes reaching almost to the White Sea.

The Baltic is the Mediterranean of the north. It has scarcely a perceptible tide, but its waters are subject to singular oscillations, affecting its level to the extent of three feet or more. For five months of the year its waters are frozen.

The navigation of the Baltic is difficult and dangerous, and is of course interrupted during winter. The entrance is complicated, being almost closed by the peninsula of Jutland and the Danish islands between Jutland and Sweden. The whole of the waters of the inland sea are thus rendered independent of the ocean.

Baltimorite. A pseudomorphous form of Serpentine after Asbestos, to which it bears considerable resemblance. It occurs in opaque greyish-green fibres with a silky lustre, at Baltimore in North America; and, also, at Kilin in Perthshire.

Baluster (Fr. balustre, Span. balaustre, possibly from bara or vara, *a rod*). A species of small short column used between piers in the upper parts of buildings, under windows, in balconies, &c. It is quite of modern introduction, that is to say, it dates shortly after the Renaissance. The form of the most ancient balustrade that is to be met with in Florence and in other parts of Italy, is that of a column, a puerility which has even in these days found admission into some of what are called Grecian buildings in the metropolis. Blondel and Chambers give rules for proportioning the baluster in cases where it is used in conjunction with the orders. In practice the term baluster is also made to signify the dwarf railing which protects a staircase, and there it is applied to small cast-iron columns, or panels, of any conceivable form, the term being applied with reference to the use, not to the nature of the decoration. There are swan-necked balusters, panelled balusters, &c.

Balustrade. A parapet or fence formed with balusters. This term is sometimes applied to cast-iron panelling.

Bambocciate. A name applied to pictures of low or vulgar life, such as the Dutch have loved to paint, and such as were termed by the Greeks Rhyparography, or literally dirt-painting. The term Bambocciate is supposed to be derived from the nickname of Bamboccio given by the Italians to Pieter Laer, the first of the characteristically Dutch painters who distinguished themselves in Rome.

Bamboo. An Asiatic genus of arborescent grasses, called *Bambusa* by botanists. They have hollow jointed stems of a hard woody texture, and externally coated with silex, and sometimes they secrete the same substance in the hollows of their stems, when it is called tabasheer. Bamboos grow with great rapidity, and their shoots are cut when young, and boiled like asparagus. They vary in size, according to the species, from 6 feet to 150 feet

in height. When small, they form walking sticks and handles to umbrellas and parasols; when sufficiently large, they are used for the framework of Indian cottages, bedsteads, floors, and a variety of domestic purposes. If split into slips they form bow-strings, and sometimes the arrows discharged from the blow-tubes of the Malays. A few species inhabit the tropical parts of America.

Bambusideæ. A section of the natural order of Grasses, comprehending the Bamboo as its type.

Bamlite. A mineral with the structure and appearance of some kinds of Kyanite, occurring at Bamle and Brakka in Norway, in gneiss.

Ban, Bann. The public notices of marriage given in church, derived from the civil law, are called Banns of Marriage. According to the law of England, the banns must be published three successive Sundays; and if the marriage be not performed within three months from the last publication, the same process must be repeated. Bishops have the power of appointing surrogates, who may grant a faculty or license to parties applying to be married without banns. But this license may only be given under certain conditions, and upon good caution and security taken, such as to supersede the necessity of public proclamation. The word 'Ban' bears a variety of significations in the Teutonic jurisprudence and usages, but all apparently connected with the original meaning of 'to proclaim or give public notice.' Hence, 1. The proclamation against an outlaw: *e.g.* the ban of the German Empire, equivalent to ecclesiastical excommunication or declaration of outlawry: whence the words banish, bandits, banditti, and to 'ban' or curse; in German, bannen, verbannen. 2. The national army of a Teutonic people levied by proclamation: hence the French 'lever le ban et l'arrière ban' (the latter word being a corruption of *heribannum*, from *heer*, an army). The French ban and arrière ban was levied for the last time in 1672, and commanded by Turenne, but behaved so ill that this feudal armament was thenceforth discontinued. 3. In the Slavonic tongues ban means master: and the lords of some of the frontier provinces of Turkey were so styled; hence the *bannat* or lordship of Temeswar, now belonging to Austria. The viceroy or governor of Croatia is styled the Ban, and enjoys extraordinary privileges.

Banana. A tall herbaceous endogenous plant, the *Musa sapientum* of botanists, having broad convex leaves with fine oblique veins, and growing in a tuft from the top of a stem formed by the union of the broad bases of the leaves. The fruit, which ripens in succession, grows in large clusters weighing many pounds, and is of the same nature as the plantain. It is a native of the West Indies, where it contributes essentially to the food of the better classes.

Banchus. A Fabrician genus of Hymenopterous insects, of the tribe *Pupivora*, and family *Ichneumonidæ*; characterised by long threadlike antennæ, abdomen compressed at the extremity, ovipositor not extended. Of this genus there are five British species, which, like the rest of the family, are parasitic in the larva state, feeding on the bodies of other insects.

Banco. In Commerce, a word of Italian origin, signifying a bank, and commonly employed to describe the bank of Venice. Banco is also used to distinguish banco money from current money at Hamburg, &c. [Exchange.]

Banco. In Law, superior courts of common law are said to sit in banco during term, the judges occupying the bench of their respective courts. [Courts of Law.]

Band (Fr. bande). In Architecture, a term used to denote what is generally called a face or fascia. To speak correctly, it signifies a flat, low, square, profiled member, without respect to its place. That member in a cornice on which modillions or dentals are cut is called the modillion band in the former, and the dental band in the latter case.

Band. In Machinery, a band is a contrivance for transmitting power with less noise and friction than attends the use of toothed gearing, and the bands used are made either of leather or gut, according to the position and usage of the engine. The employment of bands also gives the advantage of admitting the use of fast and loose pulleys, or those which are able to turn with the machinery, or without it.

Band, Military. In Music. A military band differs from a concert orchestra in the omission of the stringed instruments; it consists of wood and brass wind instruments only, with the addition of certain instruments of percussion, as drums and cymbals. The clarionets supply the place of violins, and the brass wind instruments are much more developed than in the concert orchestra. Some military bands dispense with wood instruments altogether, and are then called brass bands.

Bandanna. A style of calico-printing in which white spots are produced upon a red ground. The term is of Indian origin, and the art has been extensively adopted and improved upon in this country. (See a detailed account of Messrs. Monteith's manufactory at Glasgow, in Brande's *Quarterly Journal of Science and the Arts*, June 1823, and in Ure's *Dictionary of Arts*, &c.)

Banded. A term answering to the Lat. *fasciatus*, and denoting any body which is striated across with coloured bands.

Banditti (Ital.). Persons *declared* to be banished, exiled, or outlawed. At the present time, bandit and robber are nearly synonymous terms. The Italian bandits formed a peculiar class, and were frequently employed by the petty princes and nobles in executing their projects either of love or ambition. As late as the year 1820, they were frequently employed as escorts; and in their case the proverb 'Honour among thieves' was amply verified, for, on the payment of a stipulated sum, travellers might repose in them unlimited confidence.

Bandoleer. In the sixteenth and seventeenth centuries, a leathern belt worn over the

shoulder or round the neck, to carry in small cases the made-up charges for the musket.

Banian (more properly *Bania*). A class among the Hindus, whose office or profession is trade and merchandise. In common language, the native cashier or man of business in the service of a European is called in Bengal a Banian. In the West of India, Hindu traders in general are so styled.

Banishment. [BAN.] Expulsion from any country, province or town, by the judgment of some court or competent authority. Banishment as a species of punishment has been practised by all governments, both ancient and modern. Among the Athenians two kinds of banishment were in use: φυγή, which involved confiscation of property, and was inflicted only upon those convicted of certain crimes; and *ostracism*, by which persons were banished, if a number of citizens, in no case less than 6,000, declared that their banishment was needed for the good of the city. The Romans made use of three kinds—*relegatio*, *exilium*, and *deportatio*—which involved various grades of punishment; the last, however, being the most severe, as it subjected the delinquent to the confiscation of his property and the loss of his rights as a Roman citizen. The *second* was introduced by the emperor Augustus, and formed the kind of banishment to which, among others, Ovid was condemned. In France, deportation is classed in the third degree of infamous punishments, and is synonymous with civil death. As a criminal punishment, banishment was unknown to the ancient unwritten law of England, although voluntary exile was often adopted to evade legal prosecution. It was towards the close of Queen Elizabeth's reign that the first statute was enacted which condemned persons convicted of certain offences to leave the town or village where they lived, but it was at a much later period that the punishment of *transportation* [which see] was legalised by parliamentary statute. In Germany, many instances have recently occurred in which persons convicted of treasonable practices have had their sentences commuted into perpetual banishment; and in the German universities this punishment, inflicted on those who have grossly broken the academical laws, involves the forfeiture of all right to enter upon a professional career.

Banisteriaceæ (*Banisteria*, one of the genera). That division of malpighiaceous plants in which the fruit is samaroid, not baccate, and analogous to what is found in *Aceraceæ*.

Bank. In Commerce, an establishment for the custody and issue of money. The individual who manages a bank, or who carries on the business of banking, is called a banker.

Banks are of various kinds; some confining themselves entirely to the custody and issue of the money deposited in their hands by their customers, while others issue notes or paper money of their own. They are sometimes conducted by private individuals, and sometimes by companies consisting of an indefinite number of persons.

Utility of Banks.—Although the precious metals are, in many respects, admirably fitted to serve as a medium of exchange [MONEY], they have two very serious drawbacks, their cost, and the difficulty and expense of carrying them from place to place. If the currency of Great Britain consisted only of gold, it would amount to perhaps two hundred millions of sovereigns; and the expense attending such a currency, including the wear and tear and loss of coins, could not be reckoned at less than 6 per cent., or 12,000,000*l*. a year. The weight of 1,000 sovereigns exceeds 21 lbs. troy: so that were there nothing but coins in circulation, the conveyance of large sums from place to place to discharge accounts would be a very laborious process, and even small sums could not be conveyed without considerable difficulty; hence it is that most commercial and highly civilised nations have endeavoured to fabricate a portion of their money of less costly and heavy materials, and have resorted to various devices for economising the use of coin. Of the substitutes for coin hitherto suggested, paper is, in all respects, the most eligible. Instead of discharging their debts by a payment of the precious metals, individuals, on whose solvency the public may rely, pay them by giving a bill or draft for the sum, payable in coin at sight, or at so many days after date; and as this bill or draft passes currently from hand to hand as cash, it performs all the functions of coin, while it saves its expense to the public. A sense of the advantages that might be derived from the circulation of such bills or drafts led to the institution of banks for their regular issue.

By a bank of this description, or a bank of circulation, is meant an establishment founded by one or more individuals, known or believed to be possessed of large property, for the accommodation of the public with loans. A banker, on being applied to for a loan, does not make the advance in gold or silver or other valuable material, but enters into an engagement binding him to pay the sums specified on demand, or at some specified period. When a bank is in good credit, its notes are deemed by the public equivalent to a corresponding amount of gold or silver; and being freely accepted in payment of debts of all sorts, and easily carried about or conveyed by post, they are even more useful than an equal sum in coin. The borrowers, therefore, do not scruple to pay the same interest for the loan of a promissory note of 100*l*. or 1,000*l*. that they would do for the loan of a hundred or a thousand sovereigns. But the note costs he issuer comparatively little. He, in fact, deals in credit, or in obligations to pay, and not in real values; his profits consisting in the excess of interest derived from the notes or obligations he has issued over and above the interest of the cash or unproductive stock which he is obliged to keep in his coffers to meet the demands of the public for payment of his notes, and the expenses of his establishment.

Besides this sort of bank, there are also banks of deposit, or banks for keeping the money of individuals. A merchant, or other person using a bank of this sort, makes all his considerable payments by drafts upon his bankers and sends all the bills due to him to them to be presented, and noted, if not duly paid. By this means he saves the trouble and expense of keeping a quantity of unemployed money at home, of receiving coins or notes that are not genuine, and of making any mistakes with respect to the presentation of due bills; and in consequence of the saving of money that is thus effected, a much less quantity serves for the demand of the public.

If a bank of circulation, or an establishment for the issue of notes, fall into discredit, its notes must obviously cease to circulate. Unless when guaranteed by government, or made legal tender, no one ever takes promissory notes, except on the supposition that they will be paid when presented or when due, and that they are substantially equivalent to cash. The moment any suspicion (whether well or ill founded is so far of little consequence) arises that the issuers of notes are unable to meet their obligations, there is a run upon them for payment, and their notes are rejected by everyone.

All banks of circulation are necessarily almost at the same time banks of deposit; but there are in all civilised and commercial countries a good many of the latter class of banks only. Banks of deposit derive their profit either from their paying no interest on the sums deposited in their hands, as was the case with most of the London banks; or from their paying a less rate of interest on deposits than that for which they lend them to the public, as is the case with the Scotch banks.

English Banks.—Banking establishments for the issue of notes, and for taking care of other people's money, have existed in this country since the latter part of the seventeenth century. The Bank of England was founded in 1694, and has long been the greatest bank of circulation and deposit in the world. It grew out of a loan of 1,200,000*l.* for the public service, for which (such was the low state of public credit at the time) the subscribers were to receive 8 per cent. interest, with 4,000*l.* a year as the expense of management, and be incorporated into a banking company, denominated the Governor and Company of the Bank of England. The charter was granted for ten years; and it has since been prolonged by various renewals till the 1st August 1855, and from that date subject to a year's notice. The loans made by the Bank to government were gradually increased, till in 1800 they amounted to 14,686,800*l.* But at the renewal of the charter in 1833, a fourth part of the standing debt due to the Bank was paid off, making the sum now (1863) due by the public to that establishment, exclusive of advances on account of dead weight and other public securities, 11,015,100*l.*

From its foundation the Bank has enjoyed several peculiar privileges. The principal of these was conferred upon it in 1708, by an Act which prohibited any company from being established for the issue of notes payable on demand in England and Wales with more than *six* partners. This restriction continued till 1826, when it was abolished, in so far as respects all places more than sixty-five miles distant from London. Within that distance it still prevails; but by a late Act private banks may now have ten partners.

The Bank of England is, and always has been, the government bank, transacting for it all the banking business of the nation, receiving the produce of the taxes, loans, &c.; and paying the interest of the public debt, the drafts of the Treasury and other public departments, transferring stock, &c. For this the Bank receives, exclusive of the use of the balances of the public money in her hands, about 95,000*l.* a year.

In consequence of its employment by the government, of the restriction confining the number of partners in other banks to *ten*, and of its great capital and credit, Bank of England notes have always been held in the highest estimation; and no bank for the issue of promissory notes payable on demand has been established in or near London. In the provinces, however, numerous *private* banks (that is, banks with not more than *ten* partners) of issue and deposit have always existed. In 1792, their number is supposed to have exceeded 350. Many were destroyed by the convulsion of that year; but subsequently to 1800 they began rapidly to increase. In 1809, they amounted to 782; and in 1814, when most numerous, to 940. Since the abolition of the restriction on the number of partners, in 1826, many banks have been established; some with very large bodies of proprietors. Except in the case of the Bank of England, all the holders of stock in the other English banks, unless expressly constituted on the *limited liability* principle, granted by the Act 25 & 26 Vict. c. 89, passed in August 1862, are liable not merely for the amount of their share in the capital stock of the company, but for its whole debts, whatever may be their amount. All notes are made payable on demand; and since 1826 no notes for less than 5*l.* have been allowed to circulate.

From the first establishment of the Bank of England, down to 1797, she always paid her notes regularly when presented. But in the course of 1796, and the early part of 1797, there was, owing to the prevalence of reports of invasion, a pretty severe run upon the Bank of England, and it was at length apprehended that she might be obliged to make a temporary stoppage. To avert a contingency of this sort, an order in council was issued in February, 1797, authorising the Bank not to pay her notes in gold; and this order was subsequently confirmed by parliament, and prolonged till after the conclusion of a definitive treaty of peace.

Contrary to what might have been and was

anticipated by many, the order referred to did not stop the circulation of Bank of England notes, or diminish the confidence of the public in that establishment. The report of a committee of the House of Commons, published soon after the suspension, showed that the Bank was not merely possessed of the most ample funds to meet all her engagements, but that she had a surplus stock, after all demands upon her were deducted, of no less than 15,513,000*l.* This report, and the fact that Bank of England notes became practically legal tender, secured their circulation.

The obligation on the issuers of paper to pay their notes on demand is necessary, not only to give them circulation, but to prevent their being issued in excess. While the Bank of England was obliged to pay in specie, the value of her notes could not, and in point of fact did not, differ materially from that of gold. But in 1799, or 1800, after the check of cash payments was removed, they began to be depreciated, partly in consequence of their own over-issue, but far more through the over-issue of the paper of the country banks. The latter were multiplied to an unprecedented extent. It is of importance, too, to observe that previously to 1797 neither the Bank of England nor any of the country banks issued notes for less than 5*l.*; but both parties having commenced the issue of notes for 1*l.* in the course of that year, a new outlet was opened for the emission of paper that was particularly accessible to the country bankers. And such was the eagerness of the greater number of the latter to get their paper afloat, that individuals who could barely afford to buy stamps for bills frequently succeeded in getting the command of immense sums; and as they had nothing of their own to lose, boldly ventured on the most hazardous speculations. During the last half-dozen years of the war the depreciation of paper resulting from the circumstances now glanced at was such, that the ounce of standard gold, which should be worth only 3*l.* 17*s.* 10½*d.*, was, in 1814, actually worth 5*l.* 4*s.*, being a depreciation of 25½ per cent.

The difficulties which had been thrown during the latter years of the war in the way of importation from abroad, combined with deficient crops at home, caused an extraordinary rise in the price of corn. But no sooner had the northern ports been opened, in the autumn of 1814, than a large importation, accompanied by a heavy fall of prices, began to take place; which was still further increased after the general pacification in 1815. This fall proved ruinous to many farmers, who had been large borrowers from the country banks. In consequence of the losses arising from this and other causes that grew out of the altered situation of the country, a want of confidence was experienced; and the country banks being generally without the means of meeting any emergency, no fewer than 240 of these establishments stopped payment. There is, in fact, believed to have been, in 1814, 1815, and 1816, a greater destruction of bank paper in this country, and a wider range of bankruptcy, than had ever previously taken place anywhere else, except perhaps in France at the breaking up of the Mississippi scheme. The contraction of the currency that had been thus violently brought about raised its value nearly to par, and paved the way for the Act of 1819, the 59 Geo. III. c. 78, commonly called 'Peel's Act,' from its being introduced by Sir Robert Peel, which provided for the return to cash payments by the Bank of England at the old standard. These were resumed in 1821.

Although the bankruptcy which overspread the country in 1814, 1815, and 1816, was mainly ascribable to the defective constitution of the country banks, and to the reckless and improvident manner in which they were managed, no steps were taken when the resumption of cash payments was decided upon in 1819 to obviate any one of these sources of mischief. The consequences were such as might have been anticipated. A peculiar combination of circumstances having conspired to produce an extraordinary rage for speculative undertakings in 1824 and 1825, the country bankers gave in to the infatuation, and made the most sudden and excessive additions to their advances. In consequence the currency became redundant: and this having occasioned a heavy drain for gold on the Bank of England, the latter was, in the end, obliged to contract her issues. The country banks, whose engagements had in many instances been carried to an extent quite incommensurate with their capital, began to give way the moment they experienced an increased difficulty of obtaining pecuniary accommodation in London; and so rapid and sweeping was the destruction, that in less than six weeks above seventy banking establishments were swept off, and a vacuum created in the currency that absorbed from *eight* to *ten* millions of additional issues by the Bank of England!

This catastrophe seems at length to have satisfied the parliament and people of England that the private banking system was weak and vicious, and that it was imperatively necessary it should be amended and strengthened. In this view the clause in the Act of 1708 already referred to, prohibiting any private bank from having more than *six* partners, was repealed; and the issue of notes for less than 5*l.* was also forbidden.

The last measure shut up one of the easiest channels through which the inferior order of country bankers used to get their paper into circulation, and was thus far advantageous. But many other channels are still open to them; and the fact that a third part of all the private banks existing in England and Wales in 1792 were destroyed during the revulsion of that year, though no notes for less than 5*l.* were then in circulation, shows how little the suppression of small notes can do to obviate the mischiefs complained of. Very important advantages were, however, expected to result from the other measure, or that repealing

the Act of 1708, and consequently allowing the formation of joint-stock banks, or banks with any number of partners. But these anticipations have been only partly fulfilled. There cannot, in truth, be a greater error than to suppose that because a bank has a considerable number of partners it will necessarily be either rich or well managed. It may be neither the one nor the other. A single individual may possess more wealth than a number of individuals associated together; and the chances are, that if he engage in banking, or any other business, it will be better managed than by a company. Under our present system, and indeed it is impossible to prevent it under any system, the partners in joint-stock, or in other banks, may be men of straw, or persons without property, and unable to fulfil their engagements. It is of the essence of a secure and well-established paper currency that the notes of which it consists should be of the exact value of the gold or silver they profess to represent, and that, consequently, they should be paid the moment they are presented.

Previously to 1833, the notes of the country banks were made payable in gold; but it was then enacted that they might be paid either in gold or Bank of England notes, at the option of the issuers. Bank of England notes are now, in fact, legal tender everywhere except at the Bank and her branches.

The dividends on Bank of England stock from 1767 to the present time have been—from 1767 to 1781, 5½ per cent. per annum; from 1781 to 1788, 6 per cent.; from 1788 to 1807, 7 per cent.; from 1807 to 1823, 10 per cent.; and from 1823 to 1838, 8 per cent. In 1861 and 1862 they were 10 and 8½ per cent. The dividends are exclusive of income tax, and of the sums occasionally advanced as *bonuses*; the latter amount, since 1799, to 3,783,780*l.* over and above an increase in the capital of the Bank in 1816, which amounted to 2,910,600*l.*

New System of 1844.—The defects previously noticed in our banking system were again fully developed in 1836 and 1837. It is needless now to enter upon any investigation of the circumstances which led to the over-trading of these years; but it was carried to a great extent both here and in the United States. In nothing, however, was this more strikingly evinced, than in the rapid increase of joint-stock banks; their number, which in 1834–35 had amounted in England and Wales to 55, having risen in 1835–36 to no fewer than 100! Many of these were banks of issue, and large additions were thus suddenly made to the volume of advances and transactions on credit. The deficient harvests of 1838 and 1839, conspiring with this redundancy, occasioned a farther fall in the exchange, and a severe drain upon the Bank of England for gold. But while the latter was narrowing her issues by supplying the exporters of bullion with gold in exchange for notes, the country banks went on increasing their advances! What the former did by contracting on the one hand, the latter more than undid by letting out on the other; and in the end, the bullion in her coffers in August 1839 was reduced to 2,420,000*l.*, so that we narrowly escaped a tremendous crisis.

This perilous experience having again forcibly attracted the public attention to the state of our banking system, Sir Robert Peel was induced to attempt its improvement. The clause in the Act 3 & 4 Wm. IV. c. 98, for the renewal of the charter in 1833, which gave to parliament power to revise or cancel it in 1845, afforded a legitimate opportunity for the introduction of the new system. But, however desirable, the total suppression of the issue of notes by joint-stock and private banking companies would have been a measure too much opposed to popular prejudices, and to the real or supposed interests of a large and powerful class, to have had any chance of being carried; and there would also have been great, though inferior, difficulties in the way of the plan for taking security from the issuers. It was indeed indispensable, in attempting to obviate the defects inherent in our banking system, to proceed cautiously; to respect, in as far as possible, existing interests, and to avoid taking any step that might excite the fears or suspicions of the public; the grand difficulty being to reconcile the introduction of such a course with the adoption of any plan that would obviate in any considerable degree the defects complained of. Happily this difficult problem was satisfactorily solved by Sir Robert Peel; the measures he introduced and carried through parliament in 1844 and 1845, for the improvement of our banking system, having been so skilfully contrived as to provoke little opposition, at the same time that they effected very extensive and (as we think) most beneficial changes.

The measures in question consisted of the Act 7 & 8 Vict. c. 32, which refers to the Bank of England, and the English country banks: and the Acts 8 & 9 Vict. c. 37, 38, referring to the banks of Scotland and Ireland. The principal object of these statutes has been to obviate the chances of over-issue and of sudden fluctuations in the quantity and value of money, by limiting the power to issue notes payable on demand, and by making the amount of such notes in circulation vary more nearly than previously with the amount of bullion in the possession of the issuers. Sir Robert Peel adopted, in dealing with the Bank of England, the proposal made by Lord Overstone in 1837, for effecting a complete separation between the issuing and banking departments of that establishment. And while the directors are left at liberty to manage the latter at discretion, their management of the former, or issue department, is subjected to what is meant to be a rigid system of restraint. The Bank is allowed to issue 14,000,000*l.* of notes upon securities (of which the debt of 11,015,100*l.* lent by her to government is a part): and for whatever paper the issue department may at any time issue over

and above this maximum amount of securities, it must have an equal amount of coin and bullion in its coffers. Hence it is impracticable for the issue department to increase its issues without, at the same time, proportionally increasing its stock of coin and bullion; or to diminish the latter without proportionally diminishing the amount of paper supplied to the public and the banking department. It is no longer, as formerly, in the power of the Bank to create paper money at pleasure to supply the place of cash in any emergency in which she may be involved; and instead of less, she requires to act with more circumspection under the new system than under the old.

Weekly returns are now published of the issues of the Bank, and of the securities, bullion, &c. in her possession. The sum to be deducted by the Bank from the charge on account of the management of the national debt is in future to be 180,000*l.* instead of 120,000*l.* a year, as fixed by the Act 3 & 4 Wm. IV. c. 98. The charter since the 1st of August 1855 may be terminated at any time on twelve months' notice.

The provisions made in the Act of 1844 for restraining the country circulation were, perhaps, still more important. The maximum future issue of the joint-stock and other banks in England and Wales was limited to the average amount of the circulation of each during the twelve months preceding the 27th of April 1844; the aggregate being 3,477,321*l.* for the joint-stock, and 5,011,097*l.* for the private banks. It was farther enacted that no new bank shall be established for the issue of notes, and that the names of the partners in joint-stock and other banks shall be published annually in February.

The regulations in the statutes relating to banking in Scotland and Ireland are nearly similar. The maximum amount of notes to be issued by the banks of both countries is, in time to come, not to exceed the average amount which each bank had in circulation during the twelve months ending the 1st of May 1845. Certain returns, including amongst others the amount of gold and silver coin held by the banks, the names of the partners, &c., are to be periodically published. The small-note currency of Scotland has not been affected by the measure.

Limited Liability Act, 25 & 26 Vict. c. 89, passed August 7, 1862.—This is a general Act for the 'Incorporation, Regulation, and Winding-up of Trading Companies and other Associations,' and is founded chiefly on the consolidation of a variety of statutes passed during the previous ten years. For the first time in this country the Act extended to *non-issuing* joint-stock banking companies the privilege or principle of limited liability; that is to say, the Act prescribed that no partner in such banks should be liable for more than the total amount of the shares standing in his name, instead of, as under the former law, for the whole amount of his fortune. The immediate effect of the Act of 1862 was to occasion a violent mania for the establishment of limited-liability banks.

It may be here convenient to point out to students, that the principal reports of parliamentary committees are the following: 1797 (Lords and Commons), on the Suspension of Payment by the Bank of England; 1810, Bullion Committee; 1819 (Lords and Commons), on the Resumption of Cash Payments; 1832, on the Bank of England Charter; 1840, on Banks of Issue; 1848 (Lords and Commons), on the Commercial Distress of 1847; 1856–57 (Commons), on Bank Acts.

The measures adopted in 1844, though they deeply affected many powerful private interests, were passed with little difficulty, and were very generally approved of. In this respect, however, the public opinion has, to some extent, changed; and the Act of 1844 has been charged by various parties with having aggravated the pressure experienced by the mercantile world in 1847 and 1857. The crisis of 1847 was a consequence, partly of the railway mania of the previous year, and partly of the failure of the potato crops of 1845 and 1846. The failure in the latter year deprived fully two-thirds of the people of Ireland, and a considerable portion, also, of those of Great Britain, of their accustomed supplies of food. In consequence, there was an unprecedented importation of all sorts of corn, and a corresponding demand for bullion for exportation to meet this importation.

A great many mercantile houses that had been trading upon very insufficient capitals, or which had previously been virtually insolvent, were, of course, swept off during the crisis; and the alarm thus occasioned, though for the most part without any good foundation, gave rise to a species of panic. During the prevalence of the latter, government consented (25th October 1847) to a temporary suspension of the Act of 1844.

The difficulties of 1857 grew out of the bankruptcy of the banks in the United States in that year, and the consequent difficulty of obtaining payments of exports made to them; these circumstances having injuriously affected parties in Glasgow and elsewhere, who were largely indebted to different banking companies. The solidity of some of the latter came to be suspected, and symptoms of an internal panic began to make their appearance—and as it was most probable that bankruptcies on a large scale could not be avoided, and as no amount of bullion in the coffers of the Bank of England can resist a bonâ fide run originating in such a cause, the Act of 1844 was properly suspended till the panic was over.

In 1864 occurred another severe crisis in the money market. The extensive commercial disturbance caused by the stoppage of the supply of raw cotton from the United States, in consequence of the civil war in that country, and by the vast speculations primarily suggested by the passing of the Limited Liability Act of 1862, led, in the autumn of 1863, to a rapid

rise to 8 per cent. of the minimum rate of discount at the Bank of England. The rate fluctuated considerably in the early part of 1864, but in May it reached 9 per cent. It again fell; but on September 8 it a second time reached 9 per cent., and remained at that point till November 10. During these two months the country passed through a severe crisis. Failures were numerous and for large amounts, and the destruction of credit very considerable; and it was generally admitted, that the firm and sagacious manner in which the Bank of England was managed, during the period of difficulty, had a most important share in preventing a national calamity. The governorship of the Bank was in the hands of Mr. Kirkman Hodgson.

Scotch Banks.—The Act of 1708, preventing more than six individuals from entering into partnership for carrying on the business of banking, did not extend to Scotland. In consequence of this exemption, several banking companies, with numerous bodies of partners, have always existed in that part of the empire. The Bank of Scotland was established by Act of Parliament in 1695. By the terms of its charter it enjoyed, for twenty-one years, the exclusive privilege of issuing notes in Scotland. Its original capital was only 100,000*l.*; but it was increased to 200,000*l.* in 1744 and now amounts to 1,500,000*l.*, of which 1,000,000*l.* has been paid up.

The Royal Bank of Scotland was established in 1727. Its original capital was 151,000*l.*; at present it amounts to 2,000,000*l.*, which has been all paid up.

The British Linen Company was incorporated in 1746, for the purpose, as its name implies, of undertaking the manufacture of linen. But the views in which it originated were speedily abandoned, and it became a banking company only. Its paid-up capital amounts to 1,000,000*l.*

Exclusively of the above, there are two other chartered banks in Scotland: the Commercial Bank, established in 1810; and the National Bank of Scotland, established in 1825. The former has paid-up capital of 800,000*l.*, and the latter of 1,000,000*l.*

None of the other banking companies established in Scotland are chartered associations; and the partners are jointly and individually liable to the whole extent of their fortunes for the debts of the firms. Some of them, as the Aberdeen Town and Country Bank, the Dundee Commercial Bank, the Perth Banking Company, the Glasgow Bank, &c., have very numerous bodies of partners. Generally speaking, they have been eminently successful. Their affairs are uniformly conducted by a board of directors chosen by the shareholders. All the great joint-stock banks have numerous branches, so that there is hardly a town or village of any consequence without one or more banks.

The Bank of Scotland began to issue one-pound notes as early as 1704, and their issue has since been continued without interruption. All the Scotch banks issue notes, and taking their aggregate circulation at from 3,800,000*l.* to 4,000,000*l.*, it is supposed that from 2,000,000*l.* to 2,500,000*l.* consists of notes for 1*l.* In 1826 it was proposed to suppress one-pound notes in Scotland as well as in England; but the measure, having been strongly objected to by the people of Scotland, as at once oppressive and unnecessary, was abandoned.

Until lately there have been very few bankruptcies amongst the Scotch banks. This superior stability is to be ascribed to a variety of causes; partly to the great wealth of the early established banks, which had a considerable influence in preventing an inferior class of banks acquiring any hold on the public confidence; partly to the comparatively little risk attending the business of banking in Scotland; partly to the facilities afforded by the Scotch law for attaching a debtor's property, whether it consist of land or movables; and partly, perhaps, to the fact of the Scotch banks being but indirectly and slightly affected by the depression of the exchange and an efflux of bullion.

No doubt, however, the greater stability of the Scotch banks has been mainly ascribable to the comparative absence of speculation and to the greater security of the country trade. Latterly, however, or since the extraordinary rise of Glasgow and Dundee, matters have in this respect totally changed; and banking in Scotland has become quite as hazardous and has been quite as badly managed as in any other division of the United Kingdom. In 1857 two of the principal Scotch banks stopped payment; one afterwards resumed payment, but the other, the Western Bank, which had above 1,200 shareholders, with a large capital and an immense amount of deposits, became totally bankrupt. So great was the calamity, that the shareholders of the bank sustained a total loss of more than 2,000,000*l.* sterling. Many of them were reduced to a state of poverty. No such catastrophe had ever before occurred through banking in Scotland; and this striking example shows that banking, unless it be conducted carefully and cautiously, may degenerate in Scotland, as elsewhere, into an unmixed and gigantic evil.

The commerce and population of Scotland are too limited, and it is too remote from the metropolis, or from the centre of the moneyed world, the pivot on which the exchanges turn, to make it of importance that her currency should be in all respects identical with that of England. We believe that the Scotch attach much more importance than it deserves to the issue of paper, and especially to the issue of one-pound notes; still, however, we do not think that the circumstances are at present such as to call for or to warrant any attempt to introduce any material changes in their banking system.

All the Scotch banks receive deposits, even of the low amount of 10*l.*, and allow interest on them at from one to two per cent. below the market rate. But should a deposit be unusually

large, as from 5,000*l.* to 10,000*l.*, a special agreement is usually made with regard to it. This part of the system has been particularly advantageous. It renders the Scotch banks a sort of savings banks for all classes; and their readily receiving all sorts of deposits, at a reasonable rate of interest, has tended to diffuse a spirit of economy and parsimony among the people that would not otherwise have existed. The total deposits in the hands of the Scotch banks are believed at present (1864) to exceed 50,000,000*l.*, of which fully a half is understood to be in sums of from 10*l.* to 200*l.*

The Scotch banks make advances in the way of discounts and loans, and on what are called cash-credits or cash-accounts. By the latter are meant credits given by the banks for specified sums to individuals, each of whom gives a bond for the sum in his account, with two or more individuals as sureties for its payment. Persons having such accounts draw upon them for whatever sums within their amount they have occasion for, repaying these advances as they find opportunity, but generally within short periods. Interest is charged only on the average balance which may be found due to the bank. The total number of these accounts in Scotland in 1826 was estimated at about 12,000; and it may now, perhaps, be taken at about 16,000. They are believed to average about 500*l.*; few are for less than 100*l.*, and fewer still above 5,000*l.*

It has been contended by no less an authority than Adam Smith, that this species of accommodation gives the Scotch merchants and traders a double command of capital. 'They may discount their bills of exchange,' he says, 'as easily as the English merchants, and have, besides, the additional conveniency of their cash accounts.' But this is an obvious error. The circulation will take off only a certain quantity of paper; and to whatever extent it may be issued by means of cash-accounts, so much the less can be issued in the way of discounts. The advantage of a cash-account does not really consist in its enabling a banker to enlarge his advances to his customers, but in the extreme facility it affords of making them. An individual who has obtained such an account may operate upon it at any time he pleases, and by drafts for any amount; an advantage he could not enjoy to anything like the same extent, without an infinite deal of trouble and expense, were the loans and advances made to him through the discounting of bills. The Scotch banks draw upon London at seven days' date. This is denominated the par of exchange between London and Edinburgh.

Irish Banks.—The Bank of Ireland was established in 1783, and the same restriction as to the number of partners in other banks that formerly prevailed in England was enacted in its favour. Owing to that and other causes the bankruptcies of private banks have been more frequent in Ireland than in England. In 1821 this restriction was repealed, as respects all parts of the country more than fifty Irish miles from Dublin. Since that period several banking companies, with large bodies of partners, have been set on foot in different parts of the country; of these the Provincial Bank, founded on the Scotch model, is among the most flourishing. The Bank of Ireland is now governed by the Act 8 & 9 Vict. cap. 37. The Irish as well as the Scotch banks issue notes for 1*l.*

For accounts as to foreign banks, see *Commercial Dictionary*, and the art. 'Money' in the 8th edition of the *Encyclopædia Britannica*, with the authorities there referred to.

We subjoin the following particulars in regard to the bank-note circulation of the United Kingdom and the bullion in the Bank of England, in each year since 1844:—

Years	England and Wales			Total England and Wales	Total Scotland	Total Ireland	Total United Kingdom	Average Bullion in Bank of England
	Bank of England	Private and Joint-stock Banks						
		Private	Joint-stock					
	£	£	£	£	£	£	£	£
1845	21,730,000	4,510,000	3,190,000	29,430,000	3,290,000	6,950,000	39,670,000	15,330,000
1846	21,250,000	4,550,000	3,170,000	28,970,000	3,400,000	7,260,000	39,630,000	14,680,000
1847	20,110,000	4,540,000	3,090,000	27,740,000	3,550,000	6,010,000	37,300,000	10,610,000
1848	19,070,000	3,660,000	2,600,000	26,330,000	3,330,000	4,750,000	34,410,000	13,760,000
1849	19,490,000	3,560,000	2,630,000	25,680,000	3,220,000	4,230,000	33,130,000	15,160,000
1850	20,620,000	3,580,000	2,740,000	26,940,000	3,220,000	4,510,000	34,770,000	16,600,000
1851	20,630,000	3,460,000	2,740,000	26,830,000	3,240,000	4,460,000	34,530,000	14,560,000
1852	23,160,000	3,550,000	2,860,000	29,570,000	3,400,000	4,820,000	37,790,000	20,580,000
1853	24,030,000	3,800,000	3,050,000	30,800,000	3,800,000	5,650,000	40,330,000	17,550,000
1854	21,830,000	3,770,000	3,030,000	28,630,000	4,050,000	6,290,000	38,970,000	13,870,000
1855	19,800,000	3,840,000	3,050,000	26,690,000	4,100,000	6,360,000	37,150,000	14,240,000
1856	19,720,000	3,780,000	3,050,000	26,550,000	4,090,000	6,650,000	37,290,000	10,090,000
1857	20,331,250	3,539,632	2,939,894	26,810,777	4,143,289	6,664,889	37,368,955	10,108,250
1858	20,198,229	3,247,196	2,765,291	26,210,716	3,925,815	6,183,075	36,319,606	17,541,744
1859	21,855,250	3,397,827	2,978,234	28,231,311	4,223,105	6,938,185	39,392,601	17,928,750
1860	21,332,624	3,443,200	3,009,202	27,785,026	4,227,089	6,840,346	38,852,461	15,387,468
1861	20,026,825	3,232,538	2,893,401	26,152,764	4,199,631	6,267,219	36,619,614	12,909,017

Colonial and Foreign Banks.—During the last fifteen years a large number of banks have been formed in this country for transacting banking business in the colonies and foreign countries. These banks are in effect joint-stock companies having their operations abroad,

but constituted by shareholders in this country who subscribe the capital, appoint the directors, and, as in the case of any other joint-stock enterprise under English law, are the ultimate responsible parties. The seat of management of most of these banks is in London. Prior to the simplification of the joint-stock law some few of these banks obtained charters or letters patent. But the tendency is now to take advantage of the Limited Liability Act of 1862, already referred to. As a rule these colonial banks have been successful, and they have certainly facilitated to a large extent the growth of foreign trade.

In the course of 1863 a class of quasi-banks were introduced into this country under the name of Finance Companies. The model pointed at was that of the Crédit Mobilier at Paris. The finance companies do not undertake banking business of the ordinary kind; that is to say, they do not keep current accounts and pay cheques, nor do they discount bills as bankers are in the habit of doing for their customers. The finance companies obtain funds first by means of their paid-up capital, and secondly by means of sums taken from the public on deposit at full rates of interest and for long periods. The means thus acquired are employed in making advances to contractors of public works, in assisting railway and other similar undertakings with loans, and generally in fostering species of enterprise not within the province of a prudent banker having large liabilities payable on demand. These companies are already very numerous, and it is impossible yet to pronounce an opinion upon the position they may in the end occupy. There need be no hesitation, however, in saying that in many instances expectations have been held out, and received with favour, of a character so extreme as to be foolish and absurd.

Banks for Savings. Banks established for the receipt of small sums deposited by the poorer class of persons, and for their accumulation at compound interest. Though not so well calculated as friendly societies to enable the labouring classes to provide against sickness and old age, savings banks are very valuable institutions, and are eminently entitled to the public patronage and support. The want of a safe place of deposit for their savings, where they would yield them a reasonable interest, and whence they could withdraw them at pleasure, has formed one of the most serious obstacles to the formation of a habit of accumulation among labourers. Public banks do not generally receive a less deposit than 10*l.*; and there are but very few amongst the labouring classes who find themselves suddenly masters of so large a sum, while to accumulate so much by the weekly or monthly saving of a few shillings appears at first view almost a hopeless task; and should an individual have the resolution to attempt it, the temptation to break in upon his little stock at every call of necessity might be too strong to resist. At all events, the progressive addition of interest is lost during the period of accumulation; and it even frequently happens that the chest of the servant or labourer is not safe from the depredations of the dishonest; while the very feeling of insecurity which such a circumstance inspires must operate as a fatal check to habits of saving. A similar effect results from the instances that have often occurred, where those poor persons who had, in despite of every discouragement, accumulated a little capital, have been tempted, by the offer of a high rate of interest, to lend it to persons of doubtful characters and desperate fortunes, whose bankruptcy has involved them in irremediable ruin. It is plain, therefore, that nothing could be more advantageous with a view to the formation of those improved habits that must necessarily result from the diffusion of a spirit of frugality and forethought among the poor, than the institution of savings banks, or places of safe, convenient, and advantageous deposit for their smallest savings. They are no longer tempted, from the want of facility of investment, to waste what little they can save from their expenditure in frivolous or idle gratifications. They now feel assured that their savings, and the interest accumulated upon them, will be faithfully preserved to meet their future wants; and as there are very few who are insensible to the blessings of independence, there is no reason to suppose that they will be slow to avail themselves of the means of accumulation now in their power.

All moneys paid into any savings bank established according to the provisions of the Act 9 Geo. IV. c. 92, are ordered to be paid into the banks of England and Ireland, and vested in bank annuities or exchequer bills. The interest payable to depositors is not to exceed 3*l.* 0*s.* 10*d.* per cent. per annum. No depositor can contribute more than 30*l.*, exclusive of compound interest, to a savings bank in any one year; and the total deposits to be received from any one individual are not to exceed 150*l.*; and whenever the deposits, and compound interest accruing upon them, standing in the name of any one individual, shall amount to 200*l.*, no farther interest shall be paid upon such deposit.

A large amount of inquiry and legislation has taken place of late years on the subject of savings banks. In several instances, especially at Tralee, Bilston, and some other places, disgraceful failures of savings banks have taken place in consequence of misconduct on the part of the persons officially in charge of them, and attempts were made to fix responsibility upon the Treasury. These claims were naturally resisted as wholly untenable. The government pointed out that it had never come under any guaranty to the depositors for the ultimate safety of their funds, and that the claimants must look to the trustees and managers.

Post-Office Savings Banks.—In order, however, to provide to some extent for the poorer

classes a mode of accumulating savings in the most convenient manner and under the security of a perfect guaranty by parliament, Mr. Gladstone procured the passing of the Act 26 Vict. c. 19 (May 27, 1861), under which the Post-Office is empowered to employ its organisation for savings bank purposes. The interest allowed is 2½ per cent. per annum, and great facilities are given to depositors. At the close of 1863 the amount of capital in Post-Office savings banks was three and a half millions sterling, and in savings banks under the old regulations forty-one millions sterling. For the first practical suggestion of Post-Office savings banks the public are indebted to Mr. C. Sikes of Huddersfield.

Besides the savings banks of the more regular form, it has become a useful practice of late years for parochial authorities and others to encourage Penny Savings Banks, where sums as small as a single penny are taken; and in many cases the amounts collected in this way have been surprisingly large.

Bankruptcy (Ital. banca-rotta, *a bankrupt* whose *banco* or place of business is broken up: Wedgwood, *Dictionary of English Etymology*). In Law, the condition of a trader declared by legal authority unable to meet his engagements; regulated in England by a variety of statutes, from the 34 Hen. VIII. to 24 & 25 Vict. c. 134 (1861). The subject of bankruptcy has been one of the most difficult and hitherto unsatisfactory subjects of legislation in this country for a long period. In 1842 and 1849 elaborate Acts were passed, intended to have the effect of consolidating and simplifying the law; but, as experience showed, with only very partial success. Prior to 1842, the granting or refusing of a certificate of discharge to a bankrupt was almost wholly in the hands of his creditors, each of them acting for himself; and the abuses entailed by this system in the form of preferences and other improper modes of removing opposition, were so flagrant, that the legislature were led to confine the adjudication of certificates to the Court of Bankruptcy alone; and in order, as it was thought, to make a useful and just distinction between bankrupts, certificates were required to be of the first, second, or third class. Down to 1861, the law distinguished between traders and non-traders, and between bankruptcy and insolvency. In 1861, after much discussion, the bankruptcy and insolvency laws were again remodelled by the Act 24 & 25 Vict. c. 134 (Aug. 6, 1861); the present Lord Chancellor, Lord Westbury, then Sir Richard Bethell, taking charge of the measure. By this statute the difference between traders and non-traders, which had theretofore pervaded the law of England, was abolished; the Courts of Insolvency, with their peculiar jurisdiction, cease to exist; and the following is now the outline of English jurisprudence on the subject. Jurisdiction is vested in three commissioners in London; in the county court judges out of London. All persons become subject to the law (whether traders or not) who may have committed acts of bankruptcy. The principal of these acts are, 1. In the case of non-traders, departing or remaining out of the realm with intent to defraud creditors; 2. Remaining in prison two months (or fourteen days in the case of traders) for debt; or escaping therefrom; 3. Non-trader or trader, filing a declaration that he is unable to meet his engagements; 4. Traders suffering execution to be levied; 5. Non-payment after judgment debtor's summons. A person who has committed one of these acts may be made a bankrupt on petition from a creditor to the amount of 50*l*. But any debtor may also petition to be adjudicated a bankrupt, and such petition is an act of bankruptcy. A prisoner for debt may petition *in formâ pauperis*.

On proper proceedings being taken by the creditor, adjudication of bankruptcy takes place, on which the bankrupt's property is taken possession of by an officer of the court styled the official assignee, who holds it until the creditors who have proved their debts choose (if they think fit) a creditors' assignee for themselves. His duty is to manage, realise and recover the estate of the bankrupt, except debts under 10*l*., which are still to be recovered by the official assignee. Not later than sixty days after the meeting for the choice of an assignee the bankrupt appears to pass his last examination, state his accounts, and apply for discharge. Proof of debts by creditors may be made at any due time after adjudication and prior to the last meeting. The bankrupt is ultimately discharged, unless he has been either guilty of fraud amounting to a misdemeanour under the Act, and convicted thereof, or of misconduct specified in the Act but not amounting to misdemeanour: in either of which cases the court may suspend or refuse the discharge. The order of discharge frees the bankrupt, subject to certain exceptions, from all debts and liabilities. Provision is made for the distribution of his estate among creditors who have proved their debts, by successive dividends. Provision is also made in certain cases for substituting composition or arrangement for the proceeding to bankruptcy. An appeal lies under this Act, and the 1 & 2 Vict. c. 110, from proceedings in bankruptcy to the Lord Chancellor and Court of Appeal in Chancery sitting in bankruptcy.

It was strongly urged by the promoters of the statute of 1861, that in order to render any bankruptcy law effective, it must be administered in chief by a single responsible judge, and hence they proposed to establish a chief judge in bankruptcy, invested with powers sufficiently large to enforce the bankruptcy law in all its branches. An opposition, however, in which it is lamentable to add that mere party intrigue had a large share, defeated this part of the scheme, and the statute was finally passed with provisions which left the machinery of the old system of commissioners,

official assignees, registrars, ushers and messengers almost unchanged.

The measure of 1861 has not succeeded, and the discontent occasioned by it led to the appointment in 1864 of a Select Committee of the House of Commons, under the chairmanship of Mr. Moffatt. It is probable that the investigations of this committee will lead to another early remodelling of the English bankruptcy system, and hence we may usefully indicate, by means of a draft report presented to the committee by Mr. Moffatt (July 1864), the nature of the views now largely entertained as regards the defects of the present system, and the principles to be followed by those who desire to reform it. It is said that at present there is a great difficulty in punishing fraudulent bankrupts; that the decisions of the commissioners are most conflicting and uncertain; and that the creditors' property is negligently protected, and wasted by excessive expenses. It is said that the failures of the last forty years seem to prove that any bankruptcy Act which vests in a court of law the collection and management of the estates of bankrupts, is unsound and sure to fail. The remedy, it is said, seems to be the adoption in effect of the system which has been for some time in force in Scotland (the last Scotch Act is 19 & 20 Vict. c. 79). Under that system the creditors are left to manage the collection and distribution of the assets of the insolvent with the least possible interference of the law, only retaining an appeal to a court to prevent malversation, secure equitable distribution, and prevent fraud. It is also strongly urged that it is necessary to create a chief judge in bankruptcy, invested with powers of adjudication similar to those of the judges in equity, and of punishment similar to those formerly held by the Chief Commissioner of the Insolvent Debtors Court.

In France, the bankruptcy law was largely remodelled in 1838; and, as then settled, the plan appears to have worked tolerably well. It must be always remembered that failures in France are much more simple in all respects than in England, arising from the limited trade of France as compared with this country. The Code de Commerce (arts. 585–6) defines 'simple bankruptcy' as follows; and art. 402 of the Penal Code punishes 'simple bankruptcy' by imprisonment of not less than one month, nor more than two years. 'Simple bankruptcy' is held to have been committed, 1. If the personal expenses of the bankrupt have been excessive; 2. If he has wasted large sums in gambling or gambling operations; 3. If he has resold goods under the current price, or raised loans by pledging goods according to extravagant methods; 4. If he has entered into improvident engagements for other persons; 5. If he fails a second time before fully paying his debts under a former failure; 6. If he has not kept any, or only imperfect, books. Art. 591 of the Code de Commerce defines fraudulent bankruptcy to be concealing of books or assets, and fraudulently acknowledging obligations for which no real equivalent has been received. Art. 402 of the Penal Code punishes fraudulent bankrupts by imprisonment with hard labour 'for a period of time.'

Banksia (in honour of Sir Joseph Banks, the eminent patron of natural history, and one of the companions of Captain Cook in his second voyage). A genus of Proteaceous plants forming a conspicuous feature in the landscape of Australia, where the species are called by the colonists wild honeysuckle, and reckoned a sign of bad land. They have flowers and fruit growing in close hard downy or woolly cones, and hard, often broad leaves, on branches so close and rigid that the traveller, it is said, may literally walk without inconvenience upon the top of a wood formed of these trees.

Banlieue (Fr.). The territory without the walls, but comprised within the legal limits of a city or town.

Bann. [Ban.]

Banner (Ital. bandiera; Fr. bannière). A flag or standard under which men are united or bound for some common purpose. Mr. Wedgwood (*English Etymology*) derives this word from the Gothic *bandvo*, a sign or intimation made by *bending* the head or hand. Among the ancient Germans, the honour of bearing a banner was conferred by the emperor on the man who could bring ten vassals into the field. In latter times, petty princes assumed this privilege; and in the year 1424 Pope Eugenius IV. created Count Sforza banneret (bannerherrn) of the Roman empire. In the free towns on the Continent the banner was always carried by the chief magistrate ex officio, in solemnities or grand processions. In England, a knight banneret was created by the ceremony of cutting off the four corners of his standard and making it square. Some antiquarians trace the origin of this custom to Conan, the lieutenant of Maximus, who governed Britain in the year 383 (Gwillim, *Analogia Honorum*); while others maintain that it took its rise from the Black Prince on the field of Cressy. A great similarity seems to exist between the duties and privileges of the old knights bannerets of England and those of the *centurio primipili* (the standard bearers) among the Romans. (Tacit. *Hist.* iii. 22.) Several banners are famous in history; such as the Danish banner, taken from the Danes by Alfred the Great; and the oriflamme of the French, which, after passing through various hands, became eventually the great standard of France. [Oriflamme.]

Banner. In modern Military usage, the ordnance flag, fixed on the forepart of the drum-major's kettle-drum carriage, formerly used by the royal artillery. At present, when such a flag is carried it is affixed to the carriage of the right-hand gun of the park—generally a twelve-pounder.

In the horse equipage the *banner* of the drums and trumpets must be of the colour of the facings of the regiment; it bears the

royal cypher and crown, and the rank of the regiment.

Banneret. A knight or feudal lord, who, when summoned by the king, led his vassals to battle under his own flag or banner. This honour was also very generally adopted among European nations, and was awarded on the field of battle to such as had there distinguished themselves. Knights bannerets were considered, in England, next to barons in precedence. The dignity has not been conferred for a long period. The banner of a banneret was oblong, that of a baron square. When a knight bachelor was made banneret on the field of battle, the ceremony was performed by cutting off the ends or tails of his pennon, and thus converting it into a banner. [KNIGHT.]

Bannerole. A small flag used to mark the position to be taken up by the flank of a regiment at a review, in deploying, &c.

Banquette (Fr.). In Fortification, is a raised bank or step running along the inside of the parapet, to enable the soldier to fire over it.

Banshie. In the Mythology of Ireland, a spectre in female form, whose special office it is to announce the approaching death of the living. Such a spectre is assigned to certain families of ancient descent; and some one of the family, it is believed, is sure to die whenever the banshie is seen weeping. A similar superstition is found in Scotland, where the Bodach Glas, or Grey Spectre, plays the part of the banshie. (Sir W. Scott, *Waverley*, ch. xxx.)

Banyan. A kind of Indian Fig, the *Ficus indica* of Linnæus, forming a very large tree, which sends down roots from its branches, and these roots striking into the ground, themselves become trunks, which serve as props to the extending branches. As the tree is very long-lived, the quantity of ground covered by a single tree is almost incredible. Dr. Roxburgh says, he has seen the tree 100 feet high, and full 500 yards in circumference round the extremities of the branches. It is found wild in the skirts of the Circar mountains; its leaves are used by the Brahmans as plates to eat off; a species of bird-lime is obtained from its juice; and the fruit is eaten by birds.

Baobab. The African name of *Adansonia digitata*, a tree inhabiting the western side of Africa, and cultivated in Egypt and Abyssinia. It increases in proportion more in diameter than in height; so that it may be seen with a trunk 10 yards in thickness and only 73 feet high, its appearance being lumpish and inelegant. It is supposed that the most remarkable cases of longevity in the vegetable kingdom are afforded by this tree. Adanson is quoted by De Candolle as asserting that he saw trees which must have been 6,000 years old; and other travellers declare that, however ancient the trees may be, the bark is always green and shining, and so full of life that an abundant discharge takes place at the least wound. It is probable that the data upon which these calculations are made will not bear strict investigation; nevertheless, there can be no reasonable doubt of the Baobab trees arriving at a most unusual age. The leaves are employed in powder as an ingredient in African cookery; and the fruit has a sub-acid juice, which makes it valuable in fevers.

Baphia (Gr. *βαφή, a dipping*). A genus of *Leguminosæ*, consisting of West Tropical African trees, one of which (*B. nitida*) produces the Camwood or Barwood of commerce, much used for dyeing purposes.

Baphomet. The imaginary idol, or rather symbol, which the Templars were accused of employing in their mysterious rites. [TEMPLARS.] The distinguished orientalist, Von Hammer, published a dissertation on this subject, in which he endeavoured to revive the ancient accusations against that military order. These images, which he calls Baphomet, are to be found in some of the museums of continental cities; they are small human figures with two heads, and covered with emblems, to which Von Hammer attaches a very horrible signification. He derives the name (very improbably) from the Greek words *βαφή*, dipping or baptism, and *μῆτις*, counsel or wisdom: as if they represented the admission of the initiated to the secret mysteries of the sect. It is proper to observe, that other writers have treated all this discovery as a mere fancy of the learned orientalist, and maintain that the figures which he terms Baphomets are in reality relics of the art magic: while the word itself is supposed to be a corruption (arising from the negligence of some transcriber) of the name Mahomet, occurring in the depositions of witnesses against these unfortunate knights. (Hallam, *Middle Ages*, ch. i. note 15; Milman, *Latin Christianity*, book xii. ch. ii. p. 204.)

Baptism (Gr. *βάπτισμα*). The rite of initiation into the community of Christians, ordained by Christ Himself, when He commissioned His apostles to go and baptise all nations in the name of the Father, the Son, and the Holy Ghost (St. Matt. xxviii. 19).

It is recorded by the Evangelists, that our Saviour Himself received baptism from John; and the ceremony which the Baptist performed is allowed generally to have been an imitation of a rite in common practice among the Jews, who appear to have admitted proselytes by circumcision and baptism. Lustration, however, by water, as an initiatory rite, is of great antiquity in the East; and Christian baptism may be considered as an adaptation of a form which was generally understood to have a symbolical meaning. Accordingly, it has been recognised by all Christian communities admitting sacraments as a sacrament, although they have differed in their explanation of its nature and meaning. It is upon this point that the question of the validity of infant baptism principally depends; the words of Scripture in that particular not being allowed on all hands to be decisive, nor even the practice of the early church universally admitted. Those, therefore, who consider baptism to be a symbol of a covenant thereupon entered into between God

and the person baptised, require the understanding of the person to accompany the act, and reject the notion of sponsors undertaking to promise on the part of infants; while those who hold the belief of the Eastern and Roman churches, and those Protestant bodies which most nearly approach them, conceive this sacrament to have in itself a regenerative virtue, by which an infant may be received into participation in the promises made to the church, and be really and truly from that time forth put into the way of salvation.

Baptism was originally administered by immersion, which act is thought by some to be necessary to the sacrament. It is not clear, however, even in the Scripture history, that this ceremony was always adhered to. At present sprinkling is generally substituted for dipping, at least in northern climates. The Greek church, however, requires immersion.

Baptistery (Gr. βαπτιστήριον). In Architecture, a building destined for the purpose of administering the rite of baptism. Some authors have contended that the baptistery was anciently placed in the interior vestibules of the early churches, as are in our days baptismal fonts. But this is not so: the baptistery was entirely separated from the basilica, and even placed at some distance from it. Up to the end of the sixth century, after which period the interior vestibule of the church received it, the baptistery was distinct from the church; and excepting in a few churches, as at Florence and Ravenna, in San Giovanni Laterano, and perhaps a few others, the practice was general. The last mentioned is perhaps the most ancient remaining. One at Constantinople was so large that on one occasion it held a very numerous council. The baptistery of Florence is nearly 90 feet in diameter, octagonal, and covered with a dome. The celebrated bronze gates by Lorenzo Ghiberti, which Michael Angelo said were fit to be the gates of Paradise, enclose it. The baptistery at Pisa was finished about 1160. It is octagonal, about 129 feet in diameter, and 179 feet high. We are not aware of any building of this sort having been erected in England, unless the octagonal porch of St. Mary Redcliff, at Bristol, be cited as an example. [Absis.]

Baptists. A denomination of Christians, who deny the validity of infant baptism, and maintain the necessity of immersion. These were also the principal tenets of the Anabaptists, or Rebaptisers, with whom, however, the modern Baptists ought not to be confounded. They are subdivided into two classes, the Particular (Calvinist) and the General (Arminian) Baptists. The mode of church government is similar with both, acknowledging three orders of ministers; of whom the messengers correspond to bishops, the elders to priests, and ministering brethren to deacons. Their churches are congregational, and in respect to the election of their own ministers independent. Each denomination has, however, its general assembly, possessing some kind of authority over the whole community. The Baptists are numerous in Holland, where they are known by the title of Mennonites; and in England they form one of the principal Dissenting bodies. The total number of places of worship belonging to Baptists of various denominations in England and Wales amounted in 1851 to about 2,700. [Census.]

Bar. A bar is obstructive to trade, inasmuch as vessels of any considerable burden have to wait until high tide before they can pass it. The bar, like a delta, usually owes its existence to the deposits brought down by the river at the mouth of which it is situated.

Bar. In Heraldry, a kind of ordinary, resembling the *fess*, but containing only the fifth part of the field. Where two bars are borne in an escutcheon, they are so arranged that the whole field appears divided into five parts. A field divided by horizontal lines into four, six, eight, ten or twelve equal parts, with alternate tinctures, is termed *barry* of four, six, eight, &c.

Bar. In Law, the place in the courts where barristers or advocates plead: also where prisoners accused of felony are stationed for arraignment and trial.

Bar (Ital. barra, Fr. barre, *a beam* or *pole*). In Music, a line drawn vertically across the lines of the staff. The bars divide off the music into equal portions of time, each of which is called a bar or measure: the quantity or position contained in each is indicated by a certain mark at the commencement of the piece.

Bar, Confederation of. In Politics, was an association of a few influential Polish nobles, formed at Bar, a small town of Podolia, in the year 1767, for the purpose of freeing their country from foreign influence. Their efforts, however, were eminently unsuccessful: the small bands of the patriots were annihilated one by one; and their defeat gave rise to an event almost unprecedented in history—the partition of Poland by the three neighbouring Powers.

Baralite. A hydrated silicate of alumina, peroxide of iron, lime and magnesia found at Baralon, Côte-du-Nord, in France.

Barba (Lat. *a beard*). In Botany, a term used to denote any collection of long loose hairs into a tuft or crest, as on the petals of the Iris. Barbellæ are the short stiff hairs on the pappus of composite plants.

Barba. In Mammalogy, signifies the long tuft of hair dependent from the under jaw. In Ornithology, the same term is applied to the setiform or simple feathers, which in some species of birds depend from the skin covering the gullet or crop. In Ichthyology, a kind of spine, with the teeth pointing backwards.

Barbadoes Leg. A disease indigenous to Barbadoes, in which the limb becomes tumid, hard, and misshapen.

Barbadoes Nuts. The fruit of the *Jatropha Curcas*, a native of South America and

Asia. They are sometimes called *physic nuts*, and are virulently purgative.

Barbadoes Tar. A name often given to Petroleum [which see].

Barbarism (Gr. βαρβαρισμός). In Rhetoric, an offence against purity of style or language, which consists in employing uncouth or antiquated expressions, or in assigning to terms a different signification from that which usage has conferred on them.

Barbastelle. A small indigenous bat; *Plecotus barbastellus*, Lisson.

Barbel. An indigenous fresh-water fish (*Cyprinus barbus*, Linn.), which takes it name from the processes termed Barbels.

Barbellate (Lat. barba, *a beard*). Bearded by short, stiff, straight bristles, as in the pappus of *Centaurea*. Barbellulate is used when the roughness of the pappus is caused by extremely short points, as in *Aster*.

Barbels. Small cylindrical vermiform processes appended to the mouth of certain fishes, and subservient to the sense of touch.

Barber (Fr. barbier, from Lat. barba, *a beard*). A person who makes a trade of shaving and dressing the hair of other people for money. If we believe Varro (Plin. vii. 56), it was not until the 454th year of the city that Ticinius Mena first imported barbers into Rome from Sicily. Their shops (Tonstrinæ) soon became the resort of fashionable loungers and idlers; and Horace, to indicate the extreme notoriety of a story, says that it was 'omnibus notum tonsoribus.' Even the poorest citizens, according to the same author, sought refuge from their ennui in making a round of the barbers' shops:

> Mutat cœnacula, lectos,
> Balnea, tonsores.

That the Romans paid great attention to this department of the toilet, is obvious from the ridicule that was excited against any citizen whose hair bore marks of being cut 'inæquali tonsore' (by a bungling barber).

But besides shaving the beard, to the barbers of the Romans was assigned the delicate task of trimming the nails. Hence Plautus, *Aulul.* ii. 4. 33: 'Quin ipsi pridem tonsor ungues dempserat;' and Tibullus, i. 8. 11:

> Quid ungues
> Artificis doctâ subsecuisse manu?

As early as the time of Hippocrates, some surgical operations were considered degrading to physicians, and consequently fell to be performed by barbers. In France the council of Tours, in the year 1163, prohibited the clergy, who then shared with the Jews the practice of medicine in Christian Europe, from performing any bloody operation; and from that time the barbers remained for some centuries in uninterrupted possession of the practice of surgery. In England also, early in the sixteenth century, the barbers were incorporated with the surgeons of London (32 Hen. VIII. c. 42); but at the commencement of last century, when a new impulse was given to the science of surgery, the barbers were deprived of their honourable association with surgeons. (18 Geo. II. c. 15.) In Holland and Germany to this day the barbers are wont to wield the lancet and the razor alternately. In these countries the business of haircutting is carried on, not by the barbers, but by a distinct and superior class, the friseurs. The barber's pole has given rise to many speculations and ingenious absurdities. The fact is, that the pole was the distinguishing characteristic of a few only, indicating on the part of him who possessed it surgical as well as tonsorial ability. (For some curious remarks on the barbers of Edinburgh, vide *Creech's Statistical Account of Edinburgh*.)

Barberry. [BERBERY.]

Barbette (Fr.). In Military language, guns are said to be mounted in barbette when they are raised so as to fire over a parapet, instead of through embrasures, by which means they have a wider sweep.

Barbican (Ital. barbacane, A.-Sax. barbacan). A watch tower for the purpose of descrying the enemy: also the outer work or defence of a castle, or the fort at the entrance of a bridge. Apertures in the walls of a fortress for firing through upon the enemy are also called barbicans. Mr. Wedgwood (*Dictionary of English Etymology*) regards the word as a corruption of the Persian bâla khaneh, *an upper chamber*.

Barbiton (Gr.). An ancient musical instrument, somewhat resembling the lyre.

Barbula (Lat. dim. of barba, *a beard*). A finely divided beard-like apex to the peristome of some mosses, as in the genus *Tortula*.

Barcarolle (Ital. barcarola). A song sung by the Venetian gondoliers.

Bards (Welsh, bardd). The ancient poets of the Celtic tribes are so termed by the Roman writers, who speak of them as the priests as well as the instructors of these tribes. Lucan expressly mentions the doctrine of the immortality of the soul as one of their most characteristic tenets. After the introduction of Christianity the importance of the bards in society diminished; but in Wales, Ireland, and other Celtic districts, they continued to be held in much honour. The most ancient compositions of Welsh bards which we possess (those of Taliessin, Aneurin, and Lywarch) are supposed to be of the sixth century.

Bare Poles. The masts without any sails upon them, the ship being at sea. Under bare poles, in general, implies that the wind is so high that no sail can be exposed to it.

Bargain. [CONTRACT.]

Bargain and Sale. In Law, a species of contract through which (and by means of the Statute of Uses) realty became vested in the purchaser.

Barge (Low Lat. barga). A general name given to flat-bottomed craft of a certain size employed on rivers and canals. Also one of the larger boats of a man-of-war, between 30 and 40 feet long. Barge is also a general term for boats of state or pleasure.

Barge Boards. In Architecture, the inclined projecting boards placed at the gable of a building, which hide the ends of the horizontal timbers of a roof, and are frequently carved with trefoils, quatrefoils, flowers, and other ornaments.

Barge Course. In Architecture, that part of the tiling of a roof which projects beyond the external face of the gable of a building.

Barilla. The name given in commerce to the impure carbonate of soda, imported from Spain and the Levant. It is made by burning certain plants that grow upon the seashore, especially the salsola soda, to ashes, which are fused into grey porous masses. For an account of the places where it is produced, the quantities shipped from them, and the uses to which it is applied, see M'Culloch's *Commercial Dictionary*.

Baritone or Barytone (Gr. βαρύτονος). In Music, a high bass, sung by a male voice, the compass of which is between tenor and bass. In ancient church music it was written with the F clef on the third line of the staff. By the French, the baritone is called *basse-taille*.

Barium. The metallic base of baryta; it is of a grey colour, more than twice as heavy as water, and is instantly oxydised by air and by water. [Baryta.]

Bark or Barque (Low Lat. barca). A term applied rather vaguely to square-rigged merchant vessels. A bark has three masts which do not rake; but beyond this there appears to be no special mark to distinguish it from any other large merchantman. A bark, however, is never a steamer.

Bark (Icelandic, börkr). The exterior covering of the trunk of a tree. It is composed of cellular tissue, traversed by woody tissue passing down it longitudinally, and connected with the medullary processes of the wood. It is increased in trees by annual layers formed on its inner face, and gradually perishes on the outside as it is distended by the growth of the interior. It seldom, however, shows any very distinct trace of concentric circles, because the latter are continually displaced and disturbed by its distension. Its inner face is named liber. At the commencement of the annual growth of a tree, it separates spontaneously from the wood, in order to make room for the new matter forming beneath it. It is the depository of many of the secretions of plants, and seems to act as a living filter of a curious kind, separating certain secretions from others, and allowing a part only to pass off horizontally in the medullary processes on their way to the centre of the tree. Its use is to act as a protector to the wood, and as the channel of the sap in its descent from the leaves. Its fibre is often tenacious, and manufactured into linen or cordage. True bark only exists in Exogens and Gymnosperms; in Endogens its place is supplied by a cortical integument, which cannot be separated from the subjacent wood without violence.

The bark of many plants is employed for medicinal or economic purposes. Of medicinal barks, that known as Peruvian or Cinchona Bark, the produce of various species of *Cinchona* and the source of quinine, stands pre-eminent. Among other important kinds are Angostura Bark, the febrifugal bark of *Galipea cusparia*; Canella Bark, a stimulant aromatic bark obtained from *Canella alba*; Cascarilla Bark, the aromatic bark of *Croton Cascarilla* and other species; Quercitron Bark, the yellow dye bark of *Quercus tinctoria*; Oak Bark, the valuable tanning bark of the common oak; Winter's Bark, the tonic aromatic bark of *Drimys Winteri*; and Worm Bark, the anthelmintic bark of *Andira inermis*.

Bark, Peruvian. [Cinchona.]

Bark, Use of, in Tanning. [Tanner's Bark.]

Bark Stove. A glazed structure for tropical plants, in which there is a bed of tanners' bark, or of some other fermentable material, which will produce a moist heat. The use of bark is now, however, often superseded by hot water, distributed either in pipes or tanks beneath the bed in which the plants are placed.

Barking Irons. Instruments for removing the bark of oak and other trees, which is used for tanning. They consist of a blade or knife for cutting the bark, while yet on the trunk, across at regular distances, and of chisels or spatulæ, of different lengths and breadths, for separating the bark from the wood.

Barley. *Hordeum* is a genus of Grasses, characterised by an imbricated-spiked inflorescence, consisting of one-flowered spikelets in twos or threes. To this belongs Barley, a bread corn of considerable importance. Its native country is unknown, some ascribing it to Tartary, others to Siberia. In Spain and Sicily it produces two crops in the year; but in countries as far north as Britain it produces only one, and is rather a delicate species of grain. In England it is second in importance to wheat. It is a most valuable crop in the rotation best adapted to light or turnip soils, which, from that circumstance, are sometimes called barley lands. Where its culture is best understood, as in Norfolk, it is generally preceded by turnips or other green crops. There are two leading species of this grain in cultivation—the *Hordeum distichon*, two-rowed or Common Barley; and the *Hordeum hexastichon*, or Six-rowed Barley. One of the best known varieties of the latter, and the only one in common cultivation in Scotland, is called Bere or Bigg. It is not now used as a bread corn; but it is used very extensively in malting, and in the fatting of cattle, hogs, and poultry. The crops differ very widely, according to the land and the season, varying from 36 to 64 bushels an acre; but the most usual crop is from 36 to 40 bushels. The common weight of barley is 50 or 54 lbs. per Winchester bushel.

Barm (A.-Sax. beorma). [Yeast.]

Barnacle Geese. It was a popular superstition during the middle ages, and even down

Asia. . They are
and are virulent'

Barbadoes
Petroleum [w'

Barbaris
toric, an of
language, w
or antique
terms a d'
usage ha

Bart
Plecotu

Ba'
(*Cyp*
from

by
of
re

BARNACLES

At the end of the seventeenth century, that the birds known by this name were produced from shells found on certain trees in Scotland and the adjoining islands. To account for this supposed fact, the most absurd explanations were given by such writers as Giraldus Cambrensis, Hector Boece, and John Gerard. There can be little doubt that the fable or myth arose from a confusion of sound with the name of the Cirriped [which see], the original name of the bird being Hibernicae, or Hiberniculae, from Hibernia or Ireland, where they were chiefly found. By dropping the first syllable, the word became Bernicula, and then passed into the form Barnacla. (Max Müller, *Lectures on Language*, 2nd series, p. 550.)

Barnacles (most probably from the late Latin pernacula, diminutive of perna, *a ham*, from a supposed resemblance to a leg of pork). [Cirripeds.]

Barnacles. A colloquial word, employed to signify *spectacles*. The etymology of the term is a subject of controversy. It is regarded by Dr. Latham as being, like binnacle, a corruption from Binocle [which see]. By Professor Max Müller it is connected with the German Brille, which in a vocabulary of 1482 occurs in the form Bernlein, this word being a corruption of *beryllus*. (*Lectures on the Science of Language*, 2nd series, p. 534.)

Barnhardtite. A double sulphide of copper and iron, with traces of silver. It occurs massive, of a pale bronze-yellow colour, like that of Pyrites, but with less lustre, in a mine in Cabarras co. North Carolina.

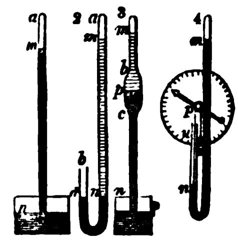
Barolite (Gr. $\beta\alpha\rho\acute{\upsilon}\varsigma$, *heavy*, and $\lambda\acute{\iota}\theta o\varsigma$, *stone*). A name given to carbonate of baryta, or Witherite, in consequence of its high specific gravity. [Barium, Baryta.]

Barometer (Gr. $\beta\acute{\alpha}\rho o\varsigma$, *weight*, and $\mu\acute{\epsilon}\tau\rho o\nu$, *measure*). A well-known instrument, invented by Torricelli, for measuring the weight or pressure of the atmosphere.

Fig. 1 represents the *Cistern Barometer*, the most simple form of the instrument. It consists of a glass tube about 34 inches long, which must be filled with mercury, and inverted in a cistern containing the same metal. When placed in the cistern, the mercury sinks till the column between the two surfaces *m* and *n* just counterbalances the pressure of the air. The space above the mercury, *a m*, is or ought to be a perfect vacuum (except as to the presence of the vapour of mercury). In this barometer, as the diameter of the cistern is generally very much greater than that of the tube, almost the whole effect of the rise or fall is perceived in the variation of the upper surface at *m*. For supposing the section of the cistern 20 times greater than that of the tube, and that the height of the column *m n* suffers a diminution of one inch; it is evident that, as all the mercury which goes out of the tube passes into the cistern, when it falls at *m* it must rise at *n*, but less in proportion as the section of the cistern exceeds that of the tube. In the case supposed, therefore, the alteration of the level at *m* will be 20 times greater than at *n*; that is to say, there will be a fall of $\frac{20}{21}$ of an inch at *m*, and a rise of $\frac{1}{21}$ of an inch at *n*.

Fig. 2 is the *Siphon Barometer*, which was also proposed by Torricelli, as being more convenient than the former. It is merely a tube hermetically sealed at the upper end, having the lower or open end bent upwards in the form of a siphon. The variations in this are only half as great as in the cistern barometer; for the tube being of the same width throughout, a diminution of the column *m n* amounting to one inch will be marked by a fall of half an inch at *m* and a rise of half an inch at *n*. This inconvenience may, however, be remedied by having the lower branch blown into a wide bulb; but as it is very difficult to procure the bulb to be blown into a perfectly regular shape, this enlargement of the bulb is found to give rise to inaccuracies.

Fig. 3 is a barometer suggested by Descartes, and executed by Huygens, in which the sensibility is greatly increased. Two tubes are cemented to the opposite ends of a pretty wide cylinder, *b c*. The lower tube and a portion of the cylinder, *c p*, are filled with mercury: above which water or spirit of wine is introduced, reaching to the top of the upper tube, which is hermetically sealed. The vacuum is made, as in the Torricellian barometer, by inverting the compound tube in a basin of mercury. The enlargement of the scale obtained



by this construction is found thus: Suppose the horizontal section of the cylinder, *b c*, to be 10 times that of the tube, and the specific gravity of mercury 14 times that of water. Let *x* be the fall of the mercury in the cylinder at *p*, corresponding to a fall of one inch of the common Torricellian barometer. The descent of the water *x* inches at *p*, will be marked by a descent of $10x$ inches in the tube at *m*. But the diminution of the height of the column of water must correspond to a diminution of $(1-x)$ inches in the height of the column of mercury of equal weight with the water; therefore, the diminution of the column of water is $14\ (1-x)$ inches. Hence, $10x = 14\ (1-x)$, or $x = \frac{7}{12}$, and the descent of the water at $m = \frac{70}{12} = 5\frac{5}{6}$; that is to say, when the Torricellian barometer falls one inch, the barometer of Descartes falls $5\frac{5}{6}$ inches. The defect of this construction is, that the air contained in the water escapes into the vacuum above, and destroys the accuracy of the instrument.

The volatility of the upper liquid also causes the instrument to be affected by changes of temperature.

Fig. 4 is the *Wheel Barometer*, proposed by Hooke. A small weight floats on the surface of the mercury in a siphon barometer, which is very nearly counterpoised by another weight, *w*, connected with the former by a string passing over a pulley, *p*. When the mercury rises at *s*, the weight *w* descends, and turns the pulley. An index attached to the axle of the pulley shows on a dial the quantity of revolution. This barometer, though not an accurate instrument, is perhaps the most useful form for general observations, where fluctuations rather than absolute measurements are of most importance.

None of the contrivances which have been described for increasing the range of the oscillations have been found to succeed well in practice. It is found to be decidedly better to apply minute divisions, than to attempt to enlarge the scale: accordingly, experimenters now adhere to one or other of the two ancient forms, the cistern barometer and the siphon barometer. The height of the column in the siphon barometer is conveniently measured by a movable scale attached to the frame which supports the tube. By means of a tangent screw, the scale is raised or lowered till its zero coincides exactly with the surface of the mercury in the lower branch; and with the assistance of a vernier, the height can be read off to the hundredth or two-hundredth of an inch with sufficient precision. The scale of the cistern barometer is usually fixed, and the bottom of the cistern is raised or lowered by a screw till the surface of the mercury in it coincides with the zero of the scale; but the scale may be movable, and its zero brought to coincide with the surface of the mercury in the basin, as in the former case. In order to determine when this coincidence takes place, recourse may be had to various expedients. The most usual is to place on the surface of the mercury a float carrying a vertical needle, some point on which answers to a fixed point on the scale, and the coincidence obtains when the two points are brought into the same level. Another contrivance to effect the same purpose was employed by Fortin, a celebrated French artist. An ivory needle is attached to the scale, pointing downwards, and having its point exactly in the same level with the zero of the scale. The image of the needle is clearly reflected from the surface of the mercury in the cistern, and the cistern is raised or lowered till the point of the needle and its image precisely coincide.

Corrections necessary.—In all barometric observations there are, in general, two essential corrections to be made; one for the capillarity or depression of the mercury in the tube, and the other for temperature. Pure mercury in a glass tube always assumes a convex surface. The following are the corrections for tubes of different diameters, according to the theory of Mr. Ivory. (*Encyclopædia Britannica*, art. 'Capillary Action.')

Diameter of Tube *Inches*	Depression *Inches*	Diameter of Tube *Inches*	Depression *Inches*
·10	·1403	·40	·0153
·15	·0863	·45	·0112
·20	·0581	·50	·0083
·25	·0407	·60	·0044
·30	·0292	·70	·0023
·35	·0211	·80	·0012

These corrections, which must always be applied to cistern barometers, show that wide tubes ought to be preferred; in fact, when the diameter of the tube exceeds half an inch, they may be safely omitted. In siphon barometers having both branches of the same diameter, the depression is equal at both ends; consequently the effect is destroyed, and no correction is required. This is a considerable advantage; for notwithstanding the most elaborate calculations, some uncertainty must always remain with regard to the exact amount of the capillary repulsion.

The correction for the temperature, which is the most important, depends on the expansion of the mercury, and the expansion of the scale on which the divisions are marked.

The expansion of mercury in bulk is ·0001001 for each degree Fahrenheit. The scale is generally of some mixed metal of which the expansion is not very well ascertained: supposing it to be equal to that of copper, the expansion would be ·0000096; therefore it will be sufficiently accurate to neglect the temperature of the scale, and assume that of the mercury to be ·0001. Hence the following practical rule for reducing an observed height to the corresponding height at the temperature of the freezing point: 'Subtract the ten-thousandth part of the observed altitude for every degree of Fahrenheit above 32.' Suppose the thermometer 54° and the barometer 30 inches, the correction will be $(54-32) \times 30 \times ·0001 =$ ·066, to be subtracted from 30 inches. In order to find the value of this correction a thermometer must be attached to the barometer, and observed at the same time. A table, showing the correction for temperature for every degree of Fahrenheit from 30° to 90°, and for every difference of half an inch in the height of the mercury from 28 to 30·5 inches, was constructed by Professor Schumacher, and is given by Mr. Baily in the *Phil. Trans.* for 1837, p. 434.

Cause of the Variations of the Barometer.—Various theories have been proposed to account for those frequent atmospherical changes which cause the rise and fall of the barometer, but none of them can be regarded as very satisfactory. Whatever tends to increase or diminish the vertical pressure will obviously cause the barometer to rise or fall. During the prevalence of northerly and easterly winds the barometer stands high, whilst winds from the opposite quarters are almost universally

accompanied by a depression of the mercurial column.

Uses of the Barometer.—The barometer is an instrument of great importance in astronomy, its indications forming an essential element in determining the amount of atmospherical refraction. [REFRACTION.] It is also, on account of its application to the measurement of altitudes, indispensable in all researches connected with climate. [HEIGHTS, MEASUREMENT OF.]

To the chemist also it is an invaluable instrument in the analysis and investigation of gaseous bodies. The purpose for which it is most commonly resorted to is to prognosticate the state of the weather. On land this is perhaps the least important of its applications, but the case is widely different at sea.

No certain rules can be laid down for prognosticating the state of the weather from the barometer. It is always to be remembered that what the barometer actually shows is the present pressure of the atmosphere, and that its variations correspond to atmospherical changes which have already taken place, and the effects of which may follow their cause at a greater or less interval.

Nevertheless in the hands of Admiral Fitzroy the barometer, when supplemented by other meteorological observations, has proved a most valuable instrument for the prognostication of storms, and it is not improbable that any considerable motion in the air and the direction of that motion will ere long be capable of infallible prediction. [ANEROID BAROMETER.]

Barometz. The hairy stem of *Cibotium Barometz*, a species of fern which, from its procumbent position and shaggy surface, looks like a crouching animal; hence called Scythian lamb.

Baron. A title common to most European nobility, the German 'Freiherr' being held equivalent. In this country the lowest rank of the peerage. The dignity appears to have been originally territorial. The higher feudatories of England, after the Norman Conquest, possessed baronies on which a certain number of knights' fees were dependent, and were bound to attend the king with a certain retinue of knights. But in process of time, many of the barons having lost by alienation great part of their lands, the distinction between *greater* and *lesser barons* began to arise; and the former alone constituted part of the great council of the sovereign, in their own right, until at some early period (supposed to have been about the reign of Henry III.) the practice of summoning individuals to parliament by the king's writ prevailed over the former usage. But this subject is involved in great uncertainty. It has, however, been very generally supposed that the dignity of baron, together with the right to sit in parliament, was at an early period annexed in many instances to the possession of certain lands or castles, which have thus been believed to confer *baronies by tenure*. But Sir Harris Nicolas, in his *Introduction to the Peerage*, gives strong reasons to show, in the first place, that it is by no means clear that persons seised of lands *per baroniam* were entitled to a summons to parliament in the reign of Edward the First; and, in the next place, that there is no positive proof of such a tenure having been legitimately established at any subsequent period. *Baronies by writ* were created by the king's writ of summons to parliament, when addressed to individuals by name. The first thus created were in 49 Hen. III., of which two (Despenser and Roos) exist at the present day. Whether, however, the dignity thus created was originally hereditary, admits of a doubt: no words to that effect are found in the ancient writs. But, in point of fact, the next heir was summoned by writ, after the decease of his ancestor, in a great majority of instances; and it has been long settled, that a summons to parliament by the king's writ, addressed to an individual, creates a barony descendible to heirs general. The earliest creation of a *barony by letters patent* took place in the 11th year of Richard II. (that of Beauchamp of Kidderminster); and therefore when a dignity of earlier creation than that year is claimed, it is presumed to have originated in a summons by writ, and consequently to be descendible to heirs general. On the death of a baron by writ without issue male, but with more daughters than one, the barony falls into *abeyance* until only one daughter or the sole heir of one daughter survives. The word Baron (baro, or varo, which seems to be radically the same with the Latin vir, Gothic vair, Anglo-Saxon wer, *a man*) appears to have simply signified 'man,' and in some cases freeman or citizen, in the laws of the Franks and other early nations. In France, the title of baron originally belonged only to those who were immediate vassals of the crown: it afterwards became applied in common usage to those who had the right of executing justice on their fiefs. The title of baron ranked, as in England, after those of duke, marquis, count, and viscount; except in Dauphiné and Brittany, where the baron had precedence of the three latter. In Germany the title of baron (Freyherr) is extremely common; but a great distinction existed, under the Empire, between the barons who were created by sovereign lords, and the barons of the Empire, the former being those immediate lords who had no voice in the Diet.

Baronet or **Knight Baronet.** The lowest degree of hereditary dignity in England. This order was instituted by King James I. in 1611, as a reward for the services of those who came forward to quell the insurrection in Ireland, and especially in the province of Ulster; each person who received it furnishing a supply sufficient to maintain thirty soldiers for three years. The creation is by patent under the great seal, and generally limited to the heirs male of the body of the grantee, although sometimes otherwise entailed. Baronets rank among themselves according to creation, and come next after the younger sons of barons.

By a clause in the patent of creation, the heir male apparent to the title can claim the honour of knighthood, on attaining the age of twenty-one, in the life of his father or grandfather. Baronets bear for distinction on their paternal coats the arms of Ulster, in a sinister hand, erect, open, and couped at the wrist, gules in a field argent. This augmentation is placed sometimes in the middle chief point, sometimes on the less point, &c. as may be most convenient, but subject to certain rules of heraldry. Baronets of Ireland were instituted by James I. nine years after the creation of baronets in England, with similar privileges and badge. Baronets of Scotland, or Nova Scotia baronets, were created by Charles I. in 1625, in furtherance of a project of colonisation in that part of America. Their badge is the ensign of Nova Scotia. It had long fallen into disuse; but was borne again in 1775, by way of revival of the order.

Barons of Exchequer. Certain Judges in England and Scotland, to whom the administration of justice is committed in causes between the sovereign and his subjects relating to the revenue. In the former country the Court of Exchequer takes cognisance of private causes also. [EXCHEQUER.]

Barony. A territorial subdivision in Ireland, which nearly corresponds with the hundred in England. Each barony is supposed to have been originally the district of a native chief. There are in all 252 baronies in Ireland.

Baroscope (Gr. βάρος, *weight*, and σκοπέω, *I observe*). A term which has been sometimes given to the barometer. According to its derivation it signifies *observer of weight*, and is properly applied to instruments which indicate variations in the weight of the atmosphere, without giving the means of absolutely measuring it. The wheel barometer of Hooke is properly a baroscope.

Baroselenite (Gr. βαρύς, *heavy*, and Selenite). A mineralogical name applied to *sulphate of baryta*, or Heavy Spar, from its high specific gravity, and the resemblance which its crystals sometimes bear to those of Selenite.

Barosma (Gr. βαρύς, *heavy*, and ὀσμή, *smell*). A genus of *Rutaceæ*, furnishing the medicinal Bucku leaves, which are produced chiefly by *B. crenata* and *serratifolia*, dwarf evergreen shrubs with small dotted leaves having a strong rue-like odour, and natives of the Cape of Good Hope. The leaves are used by the Hottentots as perfume.

Barrack (perhaps from Gael. barrachad, *a booth*, from barrach, *brushwood*). A place for soldiers to lodge in, especially in garrisons. Barracks were built under the authority of the Board of Ordnance down to the year 1792, when they were placed in charge of the deputy-adjutant-general. After some further changes, the superintendence of barracks reverted in 1834 to the Master-General of Ordnance.

The question of barrack-accommodation, as affecting the health of the army, has of late years excited deep interest; as being one in which the whole nation is directly concerned. But the subject is too wide to be entered on in detail within the limits permitted by the present work.

Barras. The resin which exudes from wounds made in the bark of fir trees.

Barratry (Old Fr. bareter, *to deceive*). A name applied by our law and that of other countries to various offences. In England, a 'common barreter' is defined by Lord Coke to be a common mover and maintainer of suits in disturbance of the peace, and in taking and detaining the possession of houses and lands or goods by false inventions. Barratry, in this sense, is an indictable offence at common law. The obtaining benefices at Rome was also an offence of *barratry*. In maritime insurance, barratry is any act of the master or mariners of a criminal nature, or grossly negligent, tending to their own benefit or to the prejudice of the owner of the ship, and without his permission. In Scotland, the crime of a judge who receives a bribe for a judgment is called *barratry*.

Barrel (Fr. baril, Span. barrila). An English measure of capacity, varying with the nature of the liquid measured. In the old measures, a barrel denoted 31½ gallons of wine, 32 gallons of ale, or 36 gallons of beer. By a statute of 1 Wm. & Mary the ale and beer barrels were equalised for every part of England except London, and ordered to contain 34 gallons. The term Barrel was formerly in use, too, as a measure of other sorts of goods. Thus, a barrel of salmon, 42 gallons; a barrel of soap, 256 pounds. In common language any hollow cylinder is called a barrel.

BARREL. In a built-up cannon, the inner tube is called the barrel. This is the most important part of the gun, as it has to receive the greatest strain of the discharge. [GUN.]

Barren Flowers. Those flowers which either have stamens and no pistil, or which have neither stamens nor pistil.

Barricade (Fr., from barre, *a bar*). A defence, either by intrenchment or raised work, made, in a hasty manner, by barrels filled with earth, heaps of stones piled up, carts, trunks of trees, or any other materials which would obstruct the passage or advance of an opposing force. The famous day of the barricades at Paris took place on the 12th of May, 1588, when the populace invested the troops of Henry III., in the Louvre, and forced him to escape from Paris. The barricades again formed an important feature in the revolutions of July 1830, and Feb. 1848.

Barrier (Fr. barrière). A strong wood palisade or paling erected to defend the entrance of a passage into a fortified place or intrenchment. The gate has a movable bar.

Barrier Treaty. In 1713, a negotiation concluded between the Dutch and the king of France shortly before the peace of Utrecht, by which the former reserved the right to hold

garrisons in certain fortresses of the Spanish Netherlands.

Barringtoniaceæ (*Barringtonia*, one of the genera). A small natural order of perigynous Exogens, related to the *Myrtaceæ*, and consisting of trees or shrubs inhabiting the tropics of the New and Old World. Several of the species are plants of great beauty; and the bark of some species of *Barringtonia* possesses narcotic qualities.

Barris. A large baboon of the Guinea coast.

Barrister. An advocate admitted to plead 'at the bar' (that is to say, without the bar, if an 'outer' barrister, popularly called 'stuff gown;' within, if a king's counsel or sergeant) in the English courts of common law and equity. Barristers were anciently styled apprentices at law, until their admission to the degree of sergeant. A student intending to be called to the bar must be admitted a member of one of the four Inns of Court (Inner and Middle Temple, Lincoln's Inn, and Gray's Inn), and reside for a certain time, during three years in some cases and five in others. The disputations or arguments (termed exercises) which were formerly required of a student have been reduced to mere matters of form, and a system of examinations in the Inns of Court has been substituted. The power to 'disbar,' or exclude a barrister from practice, is vested in the Benchers of the Inns, subject to appeal to the Judges. A barrister has no legal mode of recovering fees for his services.

Barrow (A.-Sax. beorg, beorh, *a mound*). An artificial hillock, designed to receive the bodies of the dead. The cairns of Scotland are constructed only of stones, and are almost exclusively confined to that country. The use of barrows seems to have been general in the earliest times. The barrow, raised over the Athenian dead, may still be seen on the field of Marathon. Herodotus, i. 93, describes a Lydian barrow, of which the base was formed of stones, the upper part consisting of a mound of earth. Barrows are found scattered over the plains of the Ukraine and of Tartary, and in great numbers in the Mississippi valley of North America. The barrows of England are supposed to be almost all of British construction, although the mounds properly so called are sometimes confounded with the tumuli found in Roman camps, where they serve as land marks, or for some military purpose. Barrows have been distinguished, according to peculiarities of form and construction, into long barrows, bowl, bell, pond, twin, cone, broad, &c. In the most ancient barrows, the bodies found are deposited within a cist or stone receptacle, with the head towards the north: in those of later date, this direction is not observed. The bones which have been discovered within the numerous barrows that have been opened were generally accompanied by utensils, weapons, &c.; and from the form and finish of these, some conjecture has been made as to the period of the interment. But these barrows, although generally sepulchral, are not uniformly so: in some, bones of animals only have been found. Barrow burial is said by Sir R. Hoare to have lasted from a period of unknown antiquity down to about the eighth century. (Gough, *Sepulchral Monuments*; Wörsae, *Scandinavian Antiquities*.)

Barsowite. A felspathic mineral occurring in boulders in the auriferous sand of Barsowskoi in the Ural, as the gangue of blue Corundum. It is massive, of a snow-white colour, and has a more or less pearly lustre.

Barter (Old Fr. bareter, *to deceive*, from the haggling of those who make bargains). A rule of Arithmetic by which the values of commodities of different kinds are compared.

Barton Clay. The name given to a somewhat important division (rich in fossils) of the middle Eocene tertiary rocks of the south-east of England. They are compact clays of a dark brownish-grey colour, with large bands of septaria. They are developed to a thickness of 350 feet on the cliffs of the coast of Hampshire, and include certain silicious sands at the base of Headon Hill and the top of Barton Cliff. The sands are less than 50 feet thick in some places and upwards of 250 feet in others. The Barton series correspond with the *sables moyens* of French geologists. They are rich in characteristic fossils.

Barycentric Calculus. An application to Geometry of the mechanical theory of the centre of gravity. This has been done in two distinct ways, according as *metrical* or *descriptive* geometrical properties were to be investigated. The mechanical quadrature of the Parabola by Archimedes, as also the methods given by Pappus for determining the surface and volume of a solid of revolution [GULDIN'S RULE] are examples of applications of the first kind. The barycentric calculus as at present understood, however, is of modern origin and devoted exclusively to the investigation of descriptive properties of figures. It has been developed almost entirely by Möbius, the present professor of astronomy at Leipsig. His work on the subject (*Der barycentrische Calcül*) was published in 1827, and contains the germ of the present powerful methods of trilinear and quadriplanar coordinates, by which, indeed, it has been superseded. The method of the calculus consists in defining a point as the centre of gravity of certain fixed points, to which coefficients or weights are ascribed. As long as the *relative* magnitudes of these coefficients is preserved, the point remains fixed; but when the coefficients are regarded as functions of one or more independent variables the point is restricted to a certain locus, which latter is, of course, characterised by the forms of those functions. The barycentric calculus has an algorithm of its own. For instance, the symbolical congruence

$$a\mathrm{A} + b\mathrm{B} \equiv \mathrm{S}$$

denotes that the *points* A, B, and S are in a right line, and that the last divides the line AB into segments BS, SA proportional to the numerical coefficients a, b.

Barystrontianite. A mechanical mixture of the sulphates of baryta and strontia, found in yellowish-white aggregations with a dull pearly lustre at an old lead mine on Mainland, one of the Orkneys, and on the beach at the Point of Ness.

Baryta (Gr. *βαρύς*, *heavy*). The oxide of barium, composed of 69 barium and 8 oxygen; its equivalent, therefore, is 77. Baryta is an alkaline earth, of a grey colour, not easily fusible, and poisonous. It is soluble in about 20 parts of cold water. It forms white salts with the acids, all of which are poisonous except the sulphate. The soluble salts of baryta are excellent tests of the presence of sulphuric acid, which they indicate in solution by a white precipitate, insoluble in water and in acids, and composed of 77 baryta and 40 sulphuric acid; 117 parts, therefore, of pure and dry sulphate of baryta are equivalent to 40 of sulphuric acid. There are only two abundant natural compounds of baryta: the *sulphate*, which occurs crystalline, and the *carbonate*. *Native sulphate of baryta*, *heavy spar*, or *baro-selenite*, is found in Cumberland and Westmoreland; a variety from Derbyshire is provincially called *cawk*. Native *carbonate of baryta*, or *barolite*, was first discovered at Anglesark in Lancashire by Dr. Withering, and hence called Witherite. It occurs crystallised and massive. It consists of 77 baryta and 22 carbonic acid; its equivalent, therefore, is 99.

Baryto-cœlestin. A crystallised compound of the sulphates of baryta and strontia, found in Canada and in Switzerland.

Baryto-calcite. A mineral consisting of 66·3 per cent. of carbonate of baryta, and 33·7 of carbonate of lime. It occurs in veins in Mountain Limestone, both massive and in semitransparent greyish-white crystals, at Alston Moor in Cumberland.

Barytone (Gr. *βαρύτονος*, *deep-sounding*). The male voice, the compass of which is between tenor and bass. Also a musical instrument similar to the *viol di gamba*.

Basalt. A term vaguely applied to many varieties of rock once ejected from volcanoes and now spread over the earth, or contained within the walls of a vein or dyke. Basalt is often columnar, having in the act of cooling separated into spheroids, these again breaking up into groups of imperfect six-sided columns.

The island of Staffa is one of the most celebrated basaltic monuments of the world: it is about a mile and a half in circumference; and its greatest elevation, which is upon its north-west side, is about 144 feet. Its lowermost bed upon that side is a basaltic conglomerate. The columns are compact and uniform in texture, dark greyish-black interiorly, and rusty brown where exposed to the weather. Amorphous and columnar basalt, and a stratum of pebbles foreign to the island, form its upper portion.

Fingal's Cave is justly considered as the most beautiful of ocean caverns, and owes its existence to the circumstance of the columns being jointed in that place, while their general character is to be without divisions; hence the successful invasion of the waves in this particular quarter. The entrance is 70 feet high, and resembles a Gothic arch; the width 40 to 60 feet; the length 227 feet. Its interior preserves a considerable degree of regularity throughout, its sides being columnar, and in many places broken and irregularly grouped, so as to catch a variety of direct and reflected tints, mixed with unexpected shadows, and producing a picturesque effect which no regularity could have conferred. The sea never entirely ebbs out of this cave, but the broken range of columns which forms the exterior causeway is continued on each side within it. 'This cave,' says Dr. M'Culloch, 'has been frequently described, but no description is adequate to the representation of its varied beauties and singular associations. If it were even destitute of that order and symmetry, that richness arising from multiplicity of parts combined with greatness of dimensions and simplicity of style which it possesses—still the prolonged length, the twilight gloom half concealing the playful and varying effect of reflected light, the echo of the measured surge as it rises and falls, the pellucid green of the water, and the profound and fairy solitude of the whole scene, could never fail strongly to impress any mind alive to the wonders and beauties of nature.' Mackinnon's Cave and the Boat Cave, in the same island, are also worthy the traveller's attention.

FINGAL'S CAVE.

The Giant's Causeway, and the various promontories of the coast of Antrim, form another basaltic district of great grandeur and interest. The Causeway itself consists of three piers of columns, which extend into the sea, and are walled round as it were by precipitous rocks from 200 to 400 feet high, in which are several striking columnar assemblages, vertical, inclined, curved, and horizontal, and in some places appearing as if wedged or driven into the surface of the precipice: Bengore, which bounds the Causeway on the east, consists of alternate ranges of tabular and massive with columnar basalt: Pleskin presents several colonnades of great height and regularity, separated from each other by tabular basalt; and at Fairhead there is a range of columns from 200 to nearly 300 feet in height, supported by a steep declivity, which forms a terrace nearly 600 feet above the level of the sea beneath.

Sometimes basalt rises in massive and abrupt rocks, assuming the appearance of a uniform homogeneous substance, and scarcely exhibiting any of that singular tendency to columnar regularity which we have just had occasion to admire in Staffa and the Causeway. The castles of Dumbarton, Edinburgh, and Stirling are built upon such masses. At other times it

forms low, rugged, and unpicturesque strata, sometimes remarkably bent, but without decided columns.

Good examples of columnar basalt are seen on the banks of the Rhine, between Bonn and Coblentz. Tabular basalt is very largely developed in India and again in Asia Minor.

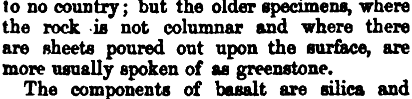
Basalt is confined to no geological age and to no country; but the older specimens, where the rock is not columnar and where there are sheets poured out upon the surface, are more usually spoken of as greenstone.

The components of basalt are silica and alumina, with variable proportions of lime, magnesia, soda, potassa, and oxide of iron, the proportions differing greatly in the several varieties.

Basanite (Gr. *βάσανος, the touchstone*). A variety of silicious slate, sometimes used as a touchstone to determine the purity of gold by the colour of its streak. [LYDIAN STONE.]

Bascinet or **Basinet.** A light basin-shaped helmet, worn by the infantry in the reigns of Edward II. and Edward III., and of Richard II. (Grose, *Ancient Armour.*)

Base (Gr. *βάσις*). In Architecture, this term is generally applied to the body which supports another. In the orders it is applied to the lower part of a column, moulded or plain, on which the shaft is placed. In the Grecian Doric the columns are without bases, and they stand immediately upon the floor, or pavement of the portico. The different bases are represented below, including the Attic base. In mediæval architecture the base of the columns plays an important part, and is highly characteristic of that style of art.



TUSCAN. ROMAN DORIC. IONIC. CORINTHIAN. COMPOSITE. ATTIC.

BASE. In Chemistry, a term chiefly applied to metallic oxides, or to the leading constituent of compounds. Thus, soda is called the base of sulphate of soda; and sodium is the metallic base of soda. Hence the distinction into salifiable and metallic bases.

BASE. In Geometry, any side upon which a figure may be supposed to rest and from which altitudes may be measured. In Geodesy, it is the right line to which all points are ultimately referred by a process of triangulation. [SURVEYING.]

Base or **Bass.** In Music, the lowest part in a concert, whether vocal or instrumental. In composition it is usually considered the fundamental or most important part, on which, as on a *base*, the superstructure is raised.

Base Clef. [CLEF.]

Base of Operations. By this term, in Military art, is meant a frontier, the course of a river, a range of forts, or any topographical or military extent of country on the imaginary line of which the corps of an army assemble: offensively, to take their departure thence into the enemy's country, and towards which in case of failure it is intended to retreat; defensively, to counteract all the measures which an invading force may attempt.

Base, Thorough. [THOROUGH BASS.]

Basella (a Malabar word). A climbing succulent-leaved plant, native of the tropical parts of Asia, representing the *Basellaceæ*, a tribe of Chenopodiaceous plants. *B. alba* is commonly cultivated instead of spinach in the East Indies.

Basicerine. [FLUOCERINE.]

Basigynium. A stalk rising above the origin of the calyx, and bearing an ovary at its apex, as in *Capparis.*

Basil. A fragrant aromatic herbaceous plant, the *Ocymum basilicum*, a native of India, whose leaves are much used in cookery for the purpose of giving a savoury flavour to dishes.

Basilic (Gr. *βασιλικός, royal*). A pharmaceutical term, formerly applied to certain powders, ointments, &c. of pre-eminent virtues and activity.

Basilica (Gr. *βασιλική*). A name given to certain buildings which were used for the purposes of law or commerce, these uses not being in every case easily distinguished. The term may, perhaps, be derived from the Archon Basileus at Athens, who gave judgment in the *Στοὰ Βασίλειος*. It thus becomes probable that both the name and the form of the building were received by the Romans from the Greeks: and it seems certain that no building of this kind existed at Rome before B.C. 184. Originally the basilica consisted simply of an open peristyle enclosing a space which was otherwise exposed to the outer air; but in later examples the peristyle itself was enclosed by an outer wall, and thus the area became divided into three parts—the central nave (*media porticus*) being divided by two rows of columns from the aisle on either side. At one end of the nave was the tribunal of the judge, which was sometimes thrown out in a circular or apsidal form, and was then called the hemicyclus. Such a plan as this is obviously capable of indefinite extension. Thus in the Basilica of Trajan the nave is flanked by a double row of columns, and consequently by two aisles on either side, while a semicircular apse is thrown out at both ends of the main body of the building. Such designs scarcely needed any change to adapt them to the purposes of Christian worship; and many of these edifices were accordingly converted into churches in the time of Constantine. The nave now served to contain the people who assembled for worship; and the tribunal of the judge gave place to seats of the bishop and presbyters which surrounded the altar. Of these buildings the church of St. John Lateran at Rome is an example.

BASILICA. In Jurisprudence, a name given to a digest of laws in sixty books, commenced by the Byzantine emperor Basilius A.D. 867, and completed A.D. 880.

Basiliscus (Gr. *βασιλίσκος*). A basilisk. This term is applied in Zoology to a harmless

genus of Saurian reptiles, of the Iguanoid family, having no femoral pores; but with palatal teeth; a covering of small scales; and an elevated dorsal crest, supported by the vertebral spines, and extending from the neck to the middle of the tail. One of the species (*Basiliscus mitratus*) supports a mitre-shaped crest on the head. Hence arose the many legends of antiquity about the supposed 'King of Serpents,' the basilisk or cockatrice, whose poison was supposed to be communicated from his eyes and breath.

Basin (Fr. bassin, Ital. basino). In Physical Geography, the space of country drained by a particular river; as the Basin of the Thames, Rhine, Rhone, &c. In Geology, the same term is applied to depressed portions of strata, forming a hollow surrounded by hills, as the 'London Basin,' the 'Paris Basin,' &c.

Basisolute (Lat. basis, and solutus, *free*). A name sometimes applied to those leaves which are prolonged at the base below the point of origin, as in the bracts of *Fumaria*, the leaves of *Sedum reflexum*, &c.

Basket (Welsh, basgéd; Latinised, bascauda). In Architecture, the central portion of the Corinthian capital, which emblem was supposed to have been derived from the use of a basket, surrounded by the acanthus plant, for the original decoration of the capitals of those columns.

Bass. A miner's name for highly bituminous coal-measure shale. [Batt.]

Bass. [Base, in Music.]

Basset. A miner's expression in some parts of England for the edges of strata as they rise or *crop* out of the earth. [Out Crop.]

Basset Horn. In Music, a wooden wind instrument, of the hautboy tribe, playing the tenor.

Bassette (dim. of Basso). In Music, the smallest species of the bass violin. Not used in the modern orchestra.

Bassia (named after Bassi, curator of the Botanic Garden at Bologna). A tropical genus of *Sapotaceæ*, consisting of trees with entire leaves and axillary flowers. *B. butyracea* is the Indian Butter tree, whose seeds yield by pressure a fatty substance of the consistence of lard, used to adulterate ghee. *B. Parkii* is the Shea tree or Butter tree of Africa, the butter of whose seeds forms an important article of commerce at Sierra Leone. *B. longifolia*, the Illupie tree of Coromandel, and *B. latifolia*, the Madhuca tree of Bengal, possess similar properties. Their timber is in some cases of good quality.

Basso Continuo (Ital.). In Music, the same as Thorough Bass.

Basso-rilievo or **Bas-relief.** [Rilievo.]

Bassoon (Ital. bassone, Fr. basson). A musical wind instrument made of wood, serving as the proper bass to the oboe and clarionet. The Italians call it *fagotto*, because composed of two pieces of wood *fagotted* as it were together. It is played by means of a bent mouthpiece and reed.

Bassorine. A modification of gum, originally discovered by Vauquelin in gum bassora

Bastard (a word of uncertain origin). By the ancient legal course of precedent in England, the fact of birth during the marriage of the parents, or within a certain time after the death of the husband (extended in some cases to a great length, as in that of the Countess of Gloucester, temp. Ed. II., to one year and seven months), was conclusive in favour of legitimacy. But this fact is now held to amount only to strong presumptive evidence, repellable by proof of non-access. The legal incapacities of an illegitimate child, by the law of England, relate wholly to the powers of inheritance and succession, to which he is in no respect entitled either as to real or personal property. In case of a divorce 'à vinculo matrimonii' in the spiritual court all the children born during the coverture are bastards, because such divorce is always upon some cause that renders the marriage null from the beginning. The Scottish law is less strict in favour of legitimacy than that of England. Two species of legitimation have been adopted in it from the civil law: one, 'per subsequens matrimonium,' by the subsequent intermarriage of the parents (but a child born in Scotland, and legitimated by subsequent intermarriage in Scotland, is not entitled to succeed to real property in England; and, if born in England, remains a bastard to all intents and purposes); and, secondly, 'per rescriptum principis,' by letters of legitimation from the crown.

Bastard Stucco. Plastering of three coats, of which the first is usually composed of the *rendering coat*, or the roughing in; the second is the *floating coat*, as in trowelled stucco; and the third, or *finishing coat*, contains a small quantity of hair mixed with the lime and sand. Bastard stucco is not hand-floated, and the trowelling is done with less labour than that required for what is called trowelled stucco.

Bastard Sugar. *Bastards* is a term applied by the sugar refiners to an impure sugar chiefly produced by the action of heat and various substances used in the refining, and which cannot be remuneratively purified. They are also called *pieces*.

Bastard Tuck Pointing. An imitation of tuck pointing, which is executed by raking out the joints of brickwork, filling in with blue mortar, and pointing upon this with white mortar.

Bastard Wing (*Alula spuria*, Linn.). Three or five quill-like feathers, placed at a small joint rising at the middle part of the wing.

Bastille (Fr.). In France, in the middle ages, towers and other outworks erected without the limits of towns were so called. The famous Bastille of Paris was an edifice of the same description, originally erected outside the city, near the modern Porte Saint Antoine. It was built by Hugues Aubriot, prêvot des marchands, in 1369; and he is said to have been the first prisoner of state confined in it after it was

employed for that purpose. The Bastille was taken by the people of Paris on the 14th of July, 1789, and demolished.

Bastinado (Ital. bastonnata, from bastone, *a stick*). An ordinary mode of punishment in Oriental countries, especially China, Turkey, and Persia. It is commonly inflicted upon the soles of the feet. According to the Turkish law, slaves and *rayahs* or tributaries alone are liable to it; but no such limitation is observed when the temper of a magistrate possessing summary authority is inflamed. This punishment is termed *zarb* in Turkish. It is extremely severe, although limited by law to the Jewish number of 39 blows, or 75 in some aggravated cases; but this regulation, like the other, is little observed in practice. (See generally, as to this species of infliction in penal law, the essay of Lanjuinais, *Sur la Bastonnade et la Flagellation pénale.*)

Bastion (Ital. bastione). In Fortification, the bastion consists of two flanks, serving for the defence of the adjacent curtains, and two faces, making with each other an angle of 60° or upwards, which command the outworks and the ground before the fortification. The space between two bastions is called the curtain. The use of the bastions is to bring every point at the foot of the rampart as much as possible under the command of the guns of the place, and that the fire may be directed on the approaches of the besiegers wherever the attack may be made. [See figure in art. FORTIFICATION.]

Bastite. A name given to Schiller Spar, in consequence of its occurrence at Basti in the Harz, where it is found in imperfectly defined greenish crystals, intermixed with serpentine.

Bat. [VESPERTILIO; DERMOPTERA; CHEIROPTERA.]

Bât Horses (Fr. bât, *a pack-saddle*). Are the horses which carry officers' baggage during a campaign. *Bât men* are the soldiers who look after these horses.

Batardeau (Fr.). In Fortification, is a strong gate to separate the wet from the dry part of a ditch; it is provided with a sluice gate.

Batata. A genus of *Convolvulaceæ*, including *B. edulis*, the Sweet Potato, a native of India, with fleshy sweet tubers, much cultivated for the sake of the latter in all the hotter parts of the world, and greatly esteemed as an article of food. Its name has now been popularly transferred to the potato (*Solanum tuberosum*), which has expelled it from cultivation in all temperate climates. *B. Jalapa* is a Mexican purgative species.

Bath (A.-Sax. bað). In Architecture, this word is reserved for a place for bathing. Among the ancients the public baths were of great extent, and consisted of a great number of apartments. The prodigious monuments of Roman magnificence seem to have been borrowed in some respects from the gymnasia of the Greeks, both the one and the other being instituted with a view to the exercise and health of the people. The word *thermæ*, which the Romans used in speaking of these edifices, signified a place for the reception of hot baths, but both hot and cold baths were generally comprised under the same building. In later times the Romans used the bath before they took their supper. The rich usually had hot and cold baths in their own houses, and it was not until the time of Augustus that the baths of ancient Rome assumed an air of grandeur and magnificence. Different authors reckon that there were as many as 800 baths in Rome. The most celebrated were those of Agrippa, Antoninus, Caracalla, Diocletian, Domitian, Nero, and Titus. Those of Diocletian were said to have been capable of containing 1,800 bathers. The vestiges of these stupendous buildings indicate the amazing magnificence, or the unbounded power of the rulers of the ancient world. Their pavements were mosaic, the ceilings vaulted and richly gilt and painted, the walls encrusted with the richest marbles; and many examples of ancient Grecian and Roman sculpture have been restored to the world from the ruins of these edifices. It was from the recesses of these buildings that Raphael took the hint for his decorations of the Vatican; and the first restorers of the arts in modern Italy drew largely from this source. The style of decoration called arabesque, or grotesque, which prevailed in Italy about this period, was mainly founded upon an imitation of the style followed in the baths of ancient Rome or its dependencies.

Of late years a great movement has taken place in favour of baths for the working people, and an Act of Parliament (called Sir H. Dukenfield's Act) has been passed for the purpose of facilitating their erection. The operation of this Act has been unsatisfactory on account of the limitations put upon the number of the superior baths, and the low price at which the cheap ones are paid; but the convenience of these baths is enough to justify the small public loss they have entailed. The reader who would desire to learn the details of this measure, and of the proceedings taken under it, is referred to the detached essay published by the Architectural Publications' Society, on *Baths and Washhouses*. In this essay will be found not only the history of the various steps taken under the Act, but also of the technical means adopted to carry out its various provisions.

BATH. In Chemistry, heated sand is often used as a medium for communicating heat, as glass and other vessels may be conveniently placed upon or immersed in it: sometimes water is used in the same way; hence *sand bath*, *water bath*, &c. The water bath is called by the old chemists Balneum Mariæ, and often abbreviated B. M.

Bath Metal. An alloy of copper and zinc, containing more zinc than in ordinary brass.

Bath, Order of the. A British order of knighthood. On the day of his coronation,

Henry IV. conferred the dignity of knighthood on forty-six esquires who had watched during the previous night, and bathed themselves, in pursuance of a very ancient custom derived from the usages of the ancient Franks. It was usual, from this period, to make similar creations of knights on royal coronations, espousals, and similar solemnities; but the custom was discontinued after the coronation of Charles II., until George I., in the eleventh year of his reign, instituted the present order of the Bath by letters patent. It consisted, exclusive of the sovereign, of a grand-master and thirty-six companions; and was a military order. In 1815, the order was greatly extended, and again in 1847, and is now composed of three classes—knights grand crosses, knights commanders, and knights companions, which classes again are each subdivided into three minor divisions—military, civil, and honorary. The knights companions take precedence of esquires. The badge worn by the grand crosses is a golden cross of eight points, enamelled white, with a lion of England between the four principal angles; on the centre a sceptre erect, or, having on the sides a rose, thistle, and shamrock, engrafted between three imperial crowns proper, encircled with a riband gules; thereon the motto of the order, 'Tria juncta in uno.' They also wear a silver star. The badge of the knights commanders is the same with that of the knights grand crosses, but smaller; their cross somewhat different. The companions have only the badge without a star.

Bathos (Gr. *depth*). In Rhetoric, a word signifying a ludicrous descent, from elevated to mean thoughts. [CLIMAX.] It has been chiefly rendered popular by Pope and Arbuthnot's *jeu d'esprit*, the '*Treatise on the Bathos*, by Martinus Scriblerus.'

Bathvillite. An inflammable mineral lately discovered by C. Greville Williams at Bathville in Scotland. It is a brown and exceedingly friable substance resembling Tripoli in appearance, and occasionally fills hollows in Torbanite.

Bathymetric Zones (Gr. βαθύς, *deep*, and μέτρον, *measure*). Divisions showing the distribution of animals and plants according to depth. Five of these zones have been defined so far as regards aquatic animals: 1. Littoral; 2. Circumlittoral; 3. Median; 4. Inframedian; 5. Abyssal. The life forms of these zones vary, of course, according to the nature of the sea bottom; and are modified by those primitive or creative laws which have produced in distant localities, under like physical conditions, species related by analogy.

Batideæ. A small group of succulent Monochlamydeous plants closely allied to *Chenopodiaceæ*, and containing but one genus, *Batis*, after which it is named. It yields barilla in great quantity.

Batolites. A genus of fossil shells, considered by Cuvier as *hippurites*.

Bâton (Fr.). The staff of a field-marshal.

BÂTON. In Music, a term denoting a rest of four semibreves.

Bâtonnier (Fr., from Low Lat. bastonarius). In French, the elected president of an order or fraternity. The *bâtonnier* of the order of advocates is elected by the whole body. In ancient times he carried in their processions a staff (bâton) with the flag of Saint Nicholas, whence the name. He is president of the Council of Discipline.

Batrachians, Batrachia (Gr. βάτραχος, *a frog*). An order of Reptilia, including the frogs and toads, and all reptiles which, like them, have naked skins and external branchiæ, in the early stage of existence; those Batrachia which retain the gills or gill-apertures throughout life are called 'perennibranchiate,' or 'amphibious.'

Batrachite (Gr. βάτραχος). A variety of Chrysolite in which a great part of the magnesia is replaced by lime. It occurs massive, of a pale greenish colour like that of a frog, with a resinous lustre, at Rizomberg, a mountain in the S. Tyrol.

Batrachomyomachia (Gr. βατραχομυομαχία). *The Battle of the Frogs and Mice*, a mock heroic poem which has come down to us, and is attributed to Homer; but there is no probability that it was written by the author of the *Iliad* or *Odyssey*. (Mure, *Critical History of Greek Literature*, ii. 358.)

Batrachospermeæ (Gr. βάτραχος, and σπέρμα, *seed*). A name proposed for such Algaceous genera as are articulated, and bear chain-like collections of spores. They mostly live in fresh water. *Batrachospermum* is the typical genus.

Batt. A highly Bituminous Shale, usually very compact, and splitting into the finest laminæ, almost invariably black, and often interstratified in layers with coal. It is termed 'Black Bass' in Lancashire, and 'Black Slag' in Flintshire. (See Jukes, *On the Geology of the South Staffordshire Coal-fields.*)

Batta. A term applied to allowances made to troops in India. *Dry batta* is money given instead of rations, and *wet batta* is what is given in kind.

Battalion (Ital. battaglione; Fr. bataillon). A division of the infantry in an army, composed of a variable number of men. At present in the English service every battalion of infantry of the line at home has a normal strength of 800 rank and file, and those in India or the colonies have 50 to 200 additional. There is, however, no specific 'peace' or 'war establishment' for battalions. Their strength is regulated from time to time by the authority of the Secretary of State for War, according to the requirements of different stations and the exigences of the service. In 1855 those serving in the Crimea consisted of no less than 2,000 rank and file, divided into 12 service companies, 4 reserve and 4 dépôt companies.

Batten. In Architecture, a name given by workmen to slips of wood from 2 to 7 inches broad, and 2½ inches thick, the length

considerable but undefined. The battens imported from Christiania, Gefle and St. Petersburg are usually from 6 to 7 inches wide, by $2\frac{1}{4}$ to $2\frac{1}{2}$ inches thick and about 16 or 20 feet long. They are usually sold by the St. Petersburg standard, that is to say, 120 battens, 12 feet long, $7'' \times 2\frac{1}{2}''$, are the recognised standard for 100 battens.

Batten Doors. A description of door filled in between a frame of deal or battens, with narrow battens laid vertically, so as to present a straight joint; the joints may terminate in a clamped flap, or be made bead butt, as the case may be.

Battened Down. When the hatchways in very bad weather are covered with strong gratings, and these with painted canvas nailed under long pieces of wood (battens), to keep the water from getting below the decks.

Battening. A kind of narrow framing used to protect walls from the effect of damp; or rather for the purpose of removing the lining from the walls for that purpose. Battening is also used for the purpose of lining the skirting of walls when there is a decided tendency to warp in the boarding used for that object, and it is usually made in narrow widths of $3\frac{1}{2}$ inches; the object of introducing these small widths being that the wood is less liable to shrink in them than when used in greater dimensions.

Batter. A term used by artificers to signify that a body does not stand upright, but leans from the spectator as he stands before it. When, on the contrary, it leans towards him, the inclination is described by saying that it overhangs.

Battering-ram. An ancient Military engine employed for beating down the walls of besieged fortresses. It consisted of a long heavy beam of timber, armed with iron at one extremity; and the effect was produced by pushing it violently with successive blows against the wall. The *ram* was worked in various ways. Sometimes it was simply supported by two files of soldiers, and the impetus given by a simultaneous thrust. More frequently it was slung from a cross beam, supported by two posts, by a rope or cable about its middle; in which case it had an oscillating motion, like a pendulum. A third sort was moved on rollers or wheels. Generally they were worked under a cover or shed (*vineæ* or *testudines*) to protect the assailants. These machines were often of immense size, and exceedingly ponderous, requiring 100 men to work them. Justus Lipsius describes a battering ram as 180 feet long, and two feet four inches in diameter, armed with an iron head weighing at least a ton and a half.

Battery (Fr. batterie, from battre, *to beat*). In Fortification, denotes the emplacement of two or more pieces of artillery destined to act offensively or defensively. Batteries may be open or covered by a parapet. They may be divided into *siege batteries* and *batteries for defence*. Siege batteries are either *elevated*, when the guns are on the natural level of the ground; *half-sunken*, when part of the earth which forms the parapet is taken from behind it, so that the guns are in a shallow trench; or *full-sunken*, when all the earth is so taken, and the guns are in a deeper ditch. A *ricochet battery* is so constructed that its guns can fire along the interior face of an enemy's work with low charges and some elevation, in order to drop the shot over the parapet among the enemy's guns, so that the shot will rebound among the latter. A *breaching battery* is constructed to breach by its fire the face of an enemy's work.

Batteries for defence are either constructed to strengthen positions in the field, or are permanent in fortresses.

The word Battery is also used to denote a certain number of field guns, in our service six, united into one command, together with the officers, men, horses, and stores. Each field and horse brigade of artillery is thus divided into batteries. In the garrison brigades the word *battery* is synonymous with *company* in the infantry.

BATTERY. In Law, the unlawful beating of another: 'assault and battery' means therefore an assault comprising such beating.

Battery, Electrical. A series of Leyden jars so arranged that they may all be discharged at once. [ELECTRICITY.]

Battery, Galvanic. [VOLTAIC ELECTRICITY.]

Battle (Ital. battaglia, Fr. bataille). In the art Military, an engagement between two hostile armies for the accomplishment of some great object. A battle is the most important event in war: it is the consummation to which all the previous combinations of a general necessarily tend; it is that grand act of war which may decide the fate of kingdoms and of nations as well as that of armies and campaigns. In the early ages of the world a battle was merely a fierce and bloody struggle, the issue of which depended more on the physical strength of the combatants than on any scientific combinations which the general could adopt; but as the arts and sciences progressed, the military system was improved; and the battle of Marathon (the first well-authenticated battle in profane history) demonstrated how far superiority in physical strength may be compensated by generalship and discipline. A further illustration of this fact is afforded in the subsequent battles of Platæa, Mantinea, and Leuctra, among the Greeks; and the banks of the Ticinus, the lake of Thrasymenus, and above all the plains of Cannæ, are memorable for engagements which for ingenuity of design and dexterity of execution have excited the admiration of soldiers in every age. But to give even a faint sketch of the various exploits which were achieved by the Grecian so-called *oblique* system, the Macedonian phalanx, and the Roman legion, and of the different military principles involved in their construction, would be to furnish a

history of these different nations; and we must content ourselves with referring the reader to the article 'Bataille,' in the *Encyclopédie des Gens du Monde*, where some concise though scientific details upon this subject will be found. Though the weapons employed in battle in modern times are widely different from those in use among the ancients, and though many circumstances have combined to give an entirely different aspect to the military systems of the two periods, still it is surprising how strong a resemblance to each other is displayed in their groundwork; and it will be found on examination that the grand principles which even in the present century were adopted by Napoleon and the duke of Wellington were practised, though imperfectly, by Epaminondas on the field of Leuctra. Indeed, it is a circumstance worthy of note, that the changes which in every age have taken place both in the manners and the weapons of nations have had no perceptible influence on the grand leading principles of military tactics. 'Les tétrarchies,' says a French author, 'et les manipules sont représentés chez les modernes par les compagnies: les xénagies ou syntagmes et les cohortes romaines, par les bataillons; enfin, les phalanges et les légions, par les régiments, les brigades ou les divisions.' There are three combinations of which a battle is susceptible: 1. *Defensive*, which consists in taking up a position, and defending it against the enemy. 2. *Offensive*, in which the object is to harass the enemy at all points and on all occasions. The third is a medium between these two, and presupposes on the part of the general sufficient skill to know when to make an attack, and when to act on the defensive. It is impossible to state precisely the principles which should guide a general in the adoption of one or other of these three systems, from the difficulty of providing against unexpected events which often occur to perplex or overturn the most matured and ingenious plans.

Battles are reducible to three orders, subject to slight modifications:—

1st. The simple parallel order, where both armies face each other, and the best soldiers win the day, independently of science.

2nd. Parallel lines reinforced on one extremity. This is most generally applicable, and by it most modern battles have been won.

3rd. The oblique order of battle, which is the best, and if skilfully applied is instantaneous and decisive in its effects.

For a full and elaborate view of the principles involved in a battle, the reader may consult with advantage Jomini's *Traité des Grandes Opérations Militaires* (Paris, 1824); a system which is founded on the united principle of a *concentration of the forces* and the *commencement of hostilities*.

Battle-axe. A Military weapon, which is purely offensive. It was not employed by the Greeks and Romans, though it was found among contemporary nations. At the siege of the Roman capitol by the Gauls under Brennus, the most distinguished warriors were armed with battle-axes; and Ammianus Marcellinus states, that this instrument formed part of the offensive armour of the Gauls from time immemorial. In England, Scotland, and Ireland, the battle-axe was much employed: the Lochaber axe, in particular, was long a formidable implement of destruction in the hands of the Scottish Highlander, and obtained an almost universal reputation.

Battlement (Fr. bâtiment, *a building*). In Architecture, this word is used to denote a wall or parapet on the top of a building, with embrasures, or open places, to look through, or to discharge missiles for the annoyance of an enemy.

Battology (Gr. βαττολογία). In Grammar, superfluous repetition.

Battue (Fr.). In Sporting, a term signifying a practice of huntsmen, which consists in encompassing a certain portion of forest, and in endeavouring by beating the bushes, as well as by loud cries, to bring out the animals of chase which may chance to be within it.

Battuta (Ital. *a beating*). In Music, the motion of beating with the hand or foot in directing the time.

Baudisserite. A Mineralogical synonym for Magnesite; after the locality Baudissero in Piedmont.

Baueraceæ (*Bauera*, so named after Mr. Bauer, their discoverer). A small natural order of New Holland shrubs with pretty purple flowers, related to *Hydrangeaceæ* and *Saxifragaceæ*. There is but one genus, *Bauera*.

Baulite. A variety of Pitchstone ejected from the volcanoes of Iceland and Faroe. It is named after the mountain of Baula in Iceland.

Baulk (Swed. balk, Dan. bielke). A piece of whole fir, being the trunk of a tree of the species usually squared for building purposes. In the metropolis the term is only applied to small lengths from 18 to 25 feet, mostly under 10 inches square, tapering considerably, and with the angles so left that the baulk is not an exact square.

Bauxite or **Beauxite.** A ferruginous hydrate of alumina. Large deposits of Bauxite occur in the department of the Bouches-du-Rhone (commune of Baux, near Arles), and in the departments of the Gard and Var in the South of France.

Bavalite. A silico-aluminate of oolitic iron found at Bavalon in France.

Bavins. Are small faggots of furze or brushwood, dipped in some inflammable composition. They are employed among the combustibles stored in a fireship.

Baxterians. In Ecclesiastical History, a name applied to those English theologians who adopted the sentiments of Richard Baxter on the subject of grace and free will, forming a sort of middle way between Calvinism and Arminianism. They never formed, strictly speaking, a sect, and the name is now disused: nevertheless, similarly modified religious opinions are common among Nonconformists at this day.

Bay. A word used to indicate any principal compartment of work, when it lies between fixed divisions: thus, a bay of flooring is the portion of the flooring between two or more divisions; a bay of roofing is that portion between two purlins. It is also used to express a portion of a barn, or any other building, when it is divided into lengths by cross partitions. A *bay window* is generally understood to mean a window so planned as to form a recess out of the room to which it belongs.

Bay (A.-Sax. bige, byge). A name applied to portions of the sea partly surrounded by land, but having a wide open communication with the ocean. Hudson's Bay is an extensive and remarkable sea on the eastern side of North America, more nearly enclosed than quite justifies the title of Bay. Its area nearly equals that of the Mediterranean. The Bay of Biscay is a better example. It is open to the Atlantic, but partly enclosed by the West of France and the North of Spain. Another instance is the Bay of Bengal in the Indian Ocean.

Baffin's Bay is a very extensive gulf, reaching far into the Arctic circle, and its shores are generally high and backed by mountains covered with perpetual snow. It is the source of a large number of the icebergs that float down the east coast of America. [Inland Seas and Gulfs.]

Bay Salt. A large-grained salt, obtained by the spontaneous evaporation of sea-water, exposed in large shallow pits (bays) to the full influence of sun and air. The term *bay salt* is often applied indiscriminately to any kind of coarse-grained salt. [Salt.]

Bayonet (Fr. baïonnette, said to be so called as having been first made or used at Bayonne). A short triangular sword or dagger fixed upon the muzzle of a musket, which is thus transformed into a thrusting weapon. The original invention and subsequent improvement of the bayonet are due to the French, who first used it in the Netherlands in 1647, and the advantages which this weapon gained to that nation soon attracted notice to its merits. In the last half of the seventeenth century, it was everywhere substituted for the pike, and in some instances it has decided the issue of an engagement without a single shot be ng fired. About the year 1690, the bayonet was first fixed to the side of the barrel, instead of being placed in the bore. Cavalry are often counted by *horses*, and infantry by *bayonets*.

Bazaar (from an Arabic word, signifying traffic or merchandise). A large square or street where merchants in Eastern countries have their shops or warehouses.

Bdellium (Gr. βδέλλιον). An African gum resin of a bitter nauseous taste and a dark-brown colour. It is sometimes mixed with myrrh.

Bdellostomes, Bdellostoma (Gr. βδέλλα, *a leech*, and στόμα, *a mouth adapted for suction*). A genus of Cyclostomous fishes.

Beach (a word of uncertain origin). A sea beach is that expanse of gravel, rolled shingle, shells, coral, and sand, or whatever corresponds to such things, exposed on the sea coast to tidal action. Not unfrequently on the south-west coast of England, the coast of Wales, the shores of the Baltic and elsewhere, such beaches are found at various levels above the regular action of the tide, and far above all such occasional marine influences as must have produced them. They are then called Raised Beaches [which see].

Beacon (A.-Sax. beacen, allied to the English words *beck, beckon*). A fire lighted by way of signal on a height, or the place where such signals are usually made. Along the southern coast of England, many of the highest hills are provincially termed 'beacon,' from this circumstance. There is a celebrated poetical description of the transmission of news by fire signals, from height to height, in the *Agamemnon* of Æschylus. The English beacons were erected under the superintendence generally of the lord high admiral; they were usually pitch-boxes, or fire-pots, and their maintenance and watching was defrayed by a rate levied on the country. The term Beacon is also applied to marks or signs raised on the shore, and on head-lands and over shoals, for guiding vessels at sea by night as well as by day.

Bead (Sax. beaðe). In Architecture, a moulding whose vertical section is semicircular.

Beak (Fr. bec, Gael. beic). In Architecture, a small fillet on the underside of the crown moulding of an entablature, followed by a hollow for the purpose of throwing off the water from it under the base of the corona.

Beak. In Botany, a hard sharp termination of any part of the fructification. It is Latinised by rostrum.

Beak-head. In large vessels with figure-heads, is the small platform between the figure-head and the bulwarks of the forecastle. It is secluded from the view of the deck, and contains the latrines of the crew.

Beam (A.-Sax. *a tree*; Ger. baum; Dutch, boom). In Architecture, a horizontal piece of stone, or of wood. The term is also applied to cast or wrought iron, which is introduced in building operations to carry a vertical load over an opening, where it resists an effort of cross strain. It is called a *tie beam*, when the piece of timber is intended to resist the outward thrust of the weight, as in the framing of a roof. The beam which is introduced in the external walls of a building to carry the weight of an upper structure is called the *bressummer*.

Beam. In Nautical language, the width of a vessel. Thus a wide vessel is said to have *more beam* than a narrow one; the beams being the strong pieces of timber stretching across the ship from side to side, for the purpose of supporting the decks and retaining the sides at their proper distance. When a ship is lying entirely on her side, she is said to be *on her beam ends*. When this is the case in a hurricane or heavy gale, there is often no other

resource to *right* the ship than cutting the masts away.

A-beam. In the direction perpendicular to the ship's length, a-midships. Thus an object seen from the middle of a vessel, 90 degrees or 8 points from the head or stern, is said to be a-beam.

Beam Filling. The filling in of masonry, or of brickwork, between beams, or joists; its height being equal to the depths of the timbers filled in.

Beam-tree. A deciduous British tree of small growth, inhabiting the mountainous parts of the country, and resembling a small apple tree, with berries like those of the mountain ash. Its leaves are strongly veined in a plaited manner, and white underneath; the wood is hard, compact, and tough, and is used for axle-trees, naves of wheels, and cogs of machinery. The *Pyrus Aria* of botanists.

Bean (A.-Sax.). The Bean, *Faba* of botanists, is a leguminous crop of considerable importance on stiff soils, occupying often a sixth of the arable land; and thus furnishing a considerable portion of the income of the farm. From 32 to 40 bushels are grown per acre. Seven or eight varieties are known to English agriculturists. It is used chiefly as horse corn; though it is also given as food to cattle, sheep, and pigs while fattening. The ordinary weight per bushel is from 60 to 64 lbs.

The Winter Bean, hardier than the other sorts, is sown in October or November and harvested in July; it is adapted to a lighter soil than the other kinds, which are sown in February and March, and are ripe in September and October.

Bean Ore or **Bohnerz.** A term applied to Brown Iron-ore when it occurs in spherical or ellipsoidal concretions, with a concentric lamellar structure.

Bear. [Ursus.]

Bear's Foot. [Hellebore.]

Bearberry. The *Arctostaphylus uva ursi*. The leaves of this plant, under the name *uva ursi*, are used as an astringent and tonic in medicine.

Beard (A.-Sax.). The gills or breathing organs of the oyster and other bivalves are vulgarly so called.

Beard. [Barba.] When applied to corn, it is used in the sense of *Awn* [which see].

Bearer. In Architecture, any upright piece used to support another.

Bearing. In Geography and Navigation, the direction, or angular distance from the meridian, in which an object is seen. The position of an observer, or of a ship at sea, may be ascertained by determining the bearing of any fixed point, whose position and distance are known, or the bearings of two known points. In the latter case the angles and a side of a triangle being given, the other sides can be easily calculated by trigonometry.

Beasts (Lat. *bestia*, Gael. *biast*). As charges in Heraldry, are said to be rampant, when represented rearing; sejant, when seated; statant, when standing; couchant, when lying; salient, when springing; passant, when walking (but the words *lodged*, *springing*, and *tripping*, are used of a beast of chase in these positions); gardant, when full-faced; regardant, looking back; dormant, sleeping; nascent, rising out of the middle of an ordinary; issuant, rising from its top or bottom. Two animals represented side by side, but moving in opposite directions, are said to be counter-passant, &c.

Beat (A.-Sax. beatan, *to beat*). In Music, a reversed shake without a turn. The word has also the same meaning as Battuta [which see].

Beat. To *beat*, *beat up*, or *beat to windwara*, in Navigation, is to make progress against the wind by a zigzag course, and is the same as working to windward.

Beatification (Low Lat. *beatificatio*). In Roman Catholic Theology, the process whereby the church confers the title of 'blessed' on one deceased: inferior, and commonly preliminary, to Canonisation [which see].

Beau Ideal (Fr.). In Painting, that beauty which is freed from the deformity and peculiarity found in nature in all individuals of a species. All the objects which nature exhibits to us have their blemishes and defects, though every eye is not capable of perceiving them: and it is only by long habit of observing what any objects of the same kind have in common that it acquires the faculty of discerning what each wants in particular. By such means the artist gains an idea of perfect nature, or what is called the *Beau Ideal*. [Ideal.]

Beaumontite. A mineral resembling Heulandite, found in minute crystals on syenite-schist with Haydenite, at Jones's Falls, near Baltimore. Named after Professor Élie de Beaumont.

Beauty (Fr. *beauté*). In the Fine Arts, that result of all the various perfections of an object, which pleases the senses, and more particularly the eye. With the painter and sculptor, nature, refined by selecting from the most perfect of the species, is the index and guide; but with the architect the creative power of nature herself is the model of imitation. Some of the sources of beauty have been seriously considered by Burke as consisting in smallness, smoothness, delicacy, and the like; but such speculations are absurd. The primary source of all beauty in the three arts is *harmony of form*; on that alone must the artist depend if he would produce a work capable of pleasing. In painting, colour decks a work with many charms; but they are all subordinate to that great effect which beautiful form, unaided by all accessories, is capable of producing on the mind. As form is constituted by lines, it seems probable that an enquiry into their nature might lead the artist to the invention of beautiful forms; and it was doubtless this feeling which led Hogarth, in his *Analysis of Beauty*, to place so much to the account of the serpentine line. But in the arts generally the principles are infinitely more extended; for

lines which, from their propriety in one art, are strikingly beautiful, become absolutely absurd as sources of beauty in others. Hence we arrive at one general conclusion, that in all of them perfect fitness and proportion so as to make the object in harmony with nature, are the surest guide to beauty of line, and thence naturally to beauty of form. If this be so, no general laws save those dependent on fitness and proportion, can be laid down; and perhaps it would not be a difficult task to trace to them all those associations which seem to be connected with the subject in its affect on the mind.

Beaver. [Castor.]

Bebeerine. A bitter basic principle contained in the bebeeru plant, or *Greenheart*, of British Guiana.

Bechicus (Gr. βηχικός, from βήξ, *a cough*). A medicine for the relief of coughs.

Beckets. On Shipboard, are hooks, or other apparatus, used for keeping ropes, tackle, oars, or spars in their appropriate places.

Bed (A.-Sax.). In Architecture, the horizontal surface on which the stones, or bricks, of walls lie in courses.

Bed. In Geology, this term is said to imply the natural layers of a stone, and it is therefore different from the planes of cleavage, which may be, and often are, very distinct from those of the stratification of the material. The general character of the bedding of a stone is that it should be more easily detached in that direction than in any other, and the fossils which may be contained in it are more frequently deposited conformably to it. Some kinds of stone are, however, very deficient in the planes of their bedding, and they yield a homogeneous, amorphous mass devoid of any divisional planes. In using materials of this description care is required to place them in the natural way of the bed, especially in cases where that characteristic is very decidedly marked. Where the bedding is not distinct, it is a matter of indifference which side may be presented to the action of the atmosphere. With some of the freshwater limestones of the Paris basin and of the Jurassic series, there are instances of stones being used with impunity in 'false bedding,' as the phrase is; but these are exceptional cases, and are manifestly liable to mislead.

Bed of Justice (Fr. lit de justice). In French History, a solemn proceeding to which the monarchs of France had recourse on particular occasions. As is well known, the parliament of that country had a right to resist any commands or decrees issued by the sovereign. If, however, the king insisted on the fulfilment of his wishes, he proceeded to hold a 'lit de justice:' i.e. he went in person to parliament, attended by the chief officers of the court, and there, mounting the throne (called in the old French language 'lit'), caused those commands or decrees which the parliament had rejected to be registered in his presence. This had the effect of intimidating the parliament into compliance; and the means which it usually adopted to intimate its dissatisfaction was to enter a protest against the whole proceeding.

Bed Moulding. In Architecture, those mouldings which are, in all the orders, between the corona and the frieze, or other large soffits.

Beds. In Geology, seams of strata, thick or thin.

Bedchamber, Lords of the (or, as they were called before the accession of the House of Hanover, *Gentlemen of the Bedchamber*). Are officers of the royal household, under the groom of the stole; their number has usually been twelve, and they wait in turn, a week each. This office is performed by *ladies* during the reign of a queen. [Household.]

Bedeguar (*the sweet-briar sponge*). A species of gall found upon various species of *Rosa*, but most frequently on the briar; it is produced by the puncture of several insects, and looks like a ball of moss, at first green, but afterwards becoming red or purple. It was formerly used in medicine as a diuretic and vermifuge. Pliny says that the ashes of this fungus, mixed with honey, or with bear's grease, were used as a liniment for baldness.

Bee. [Apis.]

Bee-eater. [Meropidans.]

Bees. On Shipboard, are pieces of elm plank bolted to the bowsprit at its upper end.

Beech (A.-Sax. bece). One of the forest trees of the north of Europe, the *Fagus sylvatica* of botanists, belonging to the natural order *Corylaceæ*. Its fruit, or mast, consists of triangular nuts enclosed in a spiny husk or cupule, of the same nature as the cup of the acorn, only of a different shape, and covering the nuts all over. Its wood, which is hard and rather handsome, is brittle and perishable, and particularly liable to become worm-eaten. It is chiefly used by turners and millwrights. The Purple and Copper Beeches seen in plantations are seedling varieties of *Fagus sylvatica*.

Beef-eater (by corruption from the French *beauffetier*, an officer appointed to watch the beauffet, buffet, or side-board). A popular appellation for the yeomen of the king's guard, partially derived from the circumstance that some of them originally were ranged at table on solemn festivals.

Beekite. An incrustation of Chalcedony, deposited in concentric circles around minute tubercles on fossils, sponges, corals or shells—generally spiral univalves—and occasionally, but rarely, upon fragments of limestone. It occurs in masses of irregular shape: most commonly they are more or less rounded, and vary in diameter from half an inch to a foot, seldom exceeding from three to six inches. Beekites have been found at Vallecas near Madrid; in Australia; on the banks of the Nerbuddah in India; and sparingly near Sidcot in Somersetshire and in the North of Scotland. They are, also, found in the New Red Conglomerate of Torbay in Devonshire, especially at Livermead Head, and about Paignton Harbour.

Named after Dr. Beeke, dean of Bristol, by whom they were first described.

Beelzebub (Heb.). A god of the Philistines, who had a famous temple at Ekron. His name signifies literally the destroyer of flies; and if we consider the torment which those insects occasion in the East, it will not seem surprising that the Philistines conferred on him this appellation. Thus, also, Apollo is thought by many to have received his name of Smintheus, as being the destroyer of mice. In the later dæmonology of the Jews, Beelzebub was represented as the chief of the devils. See the description of Milton, *Paradise Lost*, ii.

Beer (A.-Sax. bær). The wine of grain. It is usually made by fermenting an infusion of barley malt and of hops, and bears different names according to its strength and colour. It is nutritious from the sugar and mucilage which it contains, exhilarating from the spirit, and strengthening and narcotic from the hops. Professor Brande obtained the following quantities of alcohol from 100 parts of different beers:—Burton ale, between 8 and 9; Edinburgh ale, 6 to 7; Dorchester ale, 5 to 6; the average of strong ales being between 6 and 7; brown stout, 6 to 7; London porter about 4 (average); and London brewers' small beer between 1 and 2. [FERMENTATION.]

Beestings. [BIESTING.]

Beet (Fr. bette). The succulent root of *Beta vulgaris*, a Chenopodiaceous plant of biennial duration. It is used in the winter as a salad, for which purpose the red and yellow Beets of Castelnaudari are the best; for the food of cattle, under the name of Mangold Wurzel; and for the extraction of sugar. For the latter object a white-rooted variety with a purple crown is the most esteemed. Sea Beet (*Beta maritima*) is a well-known substitute for spinach. Chard or Sicilian Beet is the *Beta Cicla*. The Field Beet, or Mangold Wurzel, is now a crop of great agricultural value on account of its large produce (25 to 30 tons per acre) of nutritive succulent roots, which are good and fattening food for cattle, sheep, and pigs. It is sown in April or May (in rows 30 inches wide) at the rate of 6 or 7 lbs. of seed per acre. It is singled out at intervals of 12 to 18 inches in the row, and single roots weigh from 5 to 15 lbs. It is adapted to the stiffer class of soils, and it has introduced on them all the advantages which turnip culture has conferred on the lighter soils. The roots are drawn and pitted in October, and given to cattle and sheep during the spring months.

Beetle (A.-Sax. bytel). A large wooden hammer or mallet, with one or more handles, with which piles, stakes, wedges, &c. are driven.

BEETLE (A.-Sax. bitola). A name commonly given to the insects of the Coleopterous order, especially to such as are of a dark or obscure colour; it is also applied, but improperly, to the common pest of our kitchens, the blatta, or cockroach, which is an insect of the Orthopterous order.

Beetle or **Bettle Stones.** Names sometimes given in South Wales to septarian nodules of Clay Ironstone from the Coal Measures.

Beghards (derivation uncertain). A name in common use in the middle ages, frequently applied to the Franciscan and other mendicant orders, denoting, as some say, the practice by which they gained their subsistence. The Beghards formed a sort of intermediate class between the monks and laity, and were known under various denominations; as the tertiaries or half monks of the mendicant orders, the fraternity of the weavers, the brethren of St. Alexius, &c. But the term has also been affixed to a set of persons who, in the thirteenth century, became notorious for the frequency and ardour of their prayers.

Begoniaceæ (*Begonia*, the principal genus). A natural order of diclinous monochlamydeous Exogens, with showy pink, white, or yellow flowers, and handsome succulent leaves, which are frequently richly coloured or gaily variegated, and have one side considerably larger than the other. The leaves have large stipules, and a subacid flavour. Much difference of opinion exists among botanists as to their affinity. They generally inhabit the dampest parts of the tropics. Begonias are favourites with cultivators, both for their beauty and the facility with which they are maintained in health.

Beguins (Fr. beguin, Low Lat. beghina). A class of women throughout Germany and the Netherlands, who as early as the eleventh century, without taking vows or following the rules of any order, united themselves for devotional and charitable purposes, and were distinguished from the great body of the laity of those times by their industrious, pious, and secluded habits, and by their attention to the education of the young. Their conduct was imitated by men, who formed a union for similar purposes, and were called Beghards [which see]. The Beguins continued to exist in Germany up to the Reformation, under the name of 'seelen weiber' (spiritual women), from the interest they took in the spiritual concerns of their sex. There are now in some Roman Catholic countries societies or beguinages of females, who live together after the manner of nuns without taking vows, but by their mode of life and profession maintaining the same intermediate state between the laity and the clergy which was first remarkable in the Beghards and Beguines of the eleventh century. The most celebrated are at Ghent and Malines.

Behemoth (Heb.). The name of an animal, of which some of the characters and attributes are described in poetical language in the 40th chapter of the Book of Job. Much pains have been taken to identify the creature there referred to; but it must be remembered that the discovery and general adoption of a mode of description, which combines exactness with brevity and is applicable only to the object described, are the results of a recent and highly advanced state of zoological science. Even the prosaic, and, so far as they went, scientific descriptions of animals in the writings of Aristotle, are rarely so copious and

precise as to enable a modern naturalist to identify the existing species there referred to. But the aim of Job in the verses in which he sings of *Thau, Leviathan, Behemoth*, was to show forth the power and wisdom of the Deity and lower the pride of man, by appealing to the wonderful powers assigned to some of the most remarkable and formidable objects of animated nature with which he was acquainted; and it can hardly therefore be expected that curiosity, eager to hunt out the precise species spoken of, should be gratified. Enough of doubt has always been left to shake the most sagacious conjectures; and some recent inquirers into Biblical zoology, perceiving that the properties of Behemoth were not manifested to the letter in any known existing species, have endeavoured to make the scriptural allusions square with the characters of some one of the gigantic extinct animals: the *Iguanodon*, for example, a supposed herbivorous reptile, with a horn on the nose, and a long and flexible tail, has been selected as the species described by Job, ch. xl. The allusion, in verse 17, to a part of the generative organs, visible externally only in the class of mammalia, renders it very improbable that Behemoth could be one of the Reptilia. The exclamation, also, 'Behold he drinketh up a river and hasteth not! He trusteth that he can draw up Jordan into his mouth,' could not with any appearance of truth be applied to a species of a class of animals of which the organisation requires them to drink so little and so seldom. If a mammiferous quadruped, then Behemoth was a herbivorous and ungulate species: 'He eateth grass as an ox' (verse 15); but, unlike the males of the larger ruminants, he had not a divided scrotum, for 'the sinews of his stones were wrapt together' (verse 17). Thus from the few zoological characters which are brought under our consideration, we come to the conclusion that some huge pachyderm, whose haunt was in the fens, whose place of retreat was encompassed by the willows of the brook, and overshadowed by trees, was 'the chief of the ways of God,' in the language and mind of the sacred poet.

As there exist differences of opinion among the best Hebrew scholars as to the exact signification of the first part of verse 17, which some have rendered, 'He sitteth up,' and of the second part of verse 19, where allusion is made to some weapon, these become obviously unsafe elements, in the consideration of the zoological problem.

Bel Esprit (Fr.). A term once commonly used in England, applied to persons of sprightliness and vivacity whether in writing or in conversation.

Belay, Belaying. On Shipboard, is the act of fastening any rope of the running rigging by twisting it round a cleat, kevel, or belaying pin.

Belemnites (Gr. βέλεμνον, *a dart*). A genus of fossil Dibranchiate Cephalopods, the shells of which are chambered and perforated by a siphon, but internal. They are long, straight, and conical; and commonly called 'thunder stones.' These fossil remains are often found in chalk.

Belfry (Fr. beffroi). In Architecture, this word is applied exclusively to the towers in which bells are hung. [CAMPANILE.]

Belial. A Hebrew word, signifying wicked, worthless, and unprofitable. Thus the sons of Eli are called sons of Belial, for their idolatrous and criminal conduct (1 Sam. ii. 12); and St. Paul (2 Cor. vi. 15), in order to indicate in the strongest terms the high degree of virtue after which the Christian should strive, places Christ in direct opposition to Belial. Milton has assigned to Belial a prominent place among the adherents of Satan in his *Paradise Lost*.

Bell. A hollow vessel, or body, made so as to emit sound on being struck by some instrument. Bells are probably of very ancient origin. They are mentioned as worn on the high priest's robes (Exod. xxviii. 3). They were used by the Greeks and Romans in private houses, and in camps and garrisons. Bells are said to have been brought into use for churches by Paulinus, bishop of Nola, in Campania (whence the name Campana), about the year 400: they are first mentioned in England by Bede, towards the end of the seventh century. A bell consists of the ear, or canon, by which it is fixed to the bell cage, and of the barrel; the proportions of the barrel are—diameter at the mouth 10, diameter at the shoulder 5, height from the mouth to the shoulder 8, one-fifteenth part of the diameter being about the thickness of the *sound bow*, or that part of the bell where it is struck by the clapper, which is usually made of wrought iron.

Bell Metal. A hard, brittle, dense, and sonorous alloy of copper with tin, zinc, or some other metal. The proportion in English bells is usually about 75 per cent. of copper to 25 of tin; but they vary from 50 of copper to 33 of zinc and 17 of tin; to 80 of copper, 10 of tin, 6 of zinc, and 4 of lead; and occasionally to 72 of copper, 26·5 of tin, and 1·5 of iron. The proportion of 80 of copper to 20 of tin, or 78 of copper to 22 of tin, is the bell metal of commerce.

Bell Trap. A contrivance for the purpose of securing an air-tight communication between a sink and a cistern, or a cup for determining the flow of the water to the outfall.

Bell-metal Ore. A name which has been given to Tin Pyrites (native sulphide of tin) in consequence of its resemblance in appearance to the kind of bronze called bell metal. It is found in several Cornish mines, especially in those of Carn Brea.

Bells. On Shipboard, bells express the time as recorded by the officer of the watch. When the half-hour sand-glass runs out, the bell of the ship is struck: the number of blows increasing by one each half-hour, until the watch is expired. The bells thus reach eight in each of the long watches, and four in each dog watch.

Belladonna (*Atropa Belladonna*). The Deadly Nightshade, an acro-narcotic poison.

The name bella donna (Ital. *handsome lady*) is said to have been given from its having been used to improve the complexion. It contains the alkaloid *atropia*.

Bellerophon (Gr. Βελλεροφόντης). In the mythology of Argos, a name given to Hipponoüs, the son of Glaucus, and grandson of Sisyphus (Paus. 2. 4), when he fled from Corinth for the murder of Bellerus, and sought refuge at the court of Prœtus. There Antæa, the wife of Prœtus, conceived a violent attachment for him, which he requited as Joseph did the advances of Potiphar's wife. Nor does the analogy between the cases end here; for Antæa forthwith accused him to her husband of attempt on her virtue. Prœtus, however, unwilling to violate the laws of hospitality, sent him to Iobates, king of Lycia, his wife's father, with a letter, consisting of pictured signs, desiring him to put Bellerophon to death, and mentioning the cause. (Hence, a letter unfavourable to the bearer was called 'Literæ Bellerophontis.') With this view, Iobates sent him on various perilous expeditions: first, against the Chimæra, which Bellerophon succeeded in destroying by the aid of a winged horse called Pegasus [PEGASUS], which he had caught while drinking at the fountain Pirene in Corinth. In his next expeditions against the Solymi and the Amazons, he was equally successful (Hom. *Il.* vi. 155), and after it he married the daughter of the Lycian king. According to a version not noticed by Homer, Bellerophon, elated by his success, tried to fly to heaven on Pegasus; but Jupiter, enraged at his presumption, frustrated his attempts by sending a gad-fly, which stung the horse so violently that he became restive and threw his rider. Though maimed and shattered by the fall, Bellerophon was not killed; but he never perfectly recovered. In the *Iliad*, vi. 201, he is described as wandering alone in his later years through the Aleian plain, avoiding the path of men. Bellerophon was celebrated for his skill in horsemanship (Hor. *Od.* iii. 12. 7), and is said to have first taught the art of riding. (Plin. iv. 56.)

BELLEROPHON. A fossil shell, the animal of which was probably allied to that of *argonauta*. The genus belongs to the carboniferous and older strata.

Belles-lettres (Fr.). Polite Literature. Almost all authors concur in censuring the vague and indefinite character of this term, as at one time every branch of knowledge has been included under this denomination, at another excluded from it. In the division of the departments at the Lyceum of Arts, established at Paris in 1792, the belles-lettres comprehended general grammar, languages, rhetoric, geography, history, antiquities, and numismatics; whilst philosophy and the various branches of the mathematics were called, in contradistinction, sciences. Rollin and Rosenstein, who professedly treat of the belles-lettres, comprehend under the term all those branches of knowledge which chiefly occupy the memory and the understanding, and do not form part either of the superior sciences or of the mechanical professions. In an enquiry of this kind, reference must necessarily be made to Hume, who, both from the nature of his pursuits and the bent of his mind, was well qualified to give an opinion, and who asserts, that the belles-lettres improve our sensibility for all the tender and agreeable passions, at the same time that they render the mind incapable of the rougher and more boisterous emotions.

But though it would appear difficult to reduce this term within the limits of a precise and accurate definition, there can be little doubt that there are few terms which present so distinct a meaning to each individual mind. The influence of the belles-lettres has been felt and acknowledged in all ages. The tribute paid to them by Cicero in his defence of Archias is familiar to all. In the beautiful letter to Mæcenas, who was afflicted with some mental distemper, Horace first advises his friend to have recourse to the study of polite literature, and then concludes in these general terms:—

> Invidus, iracundus, iners, vinosus, amator,
> Nemo adeo ferus est, ut non mitescere possit,
> Si modo culturæ patientem commodet aurem.
> *Ep.* i. 1. 40.

It would greatly exceed our limits to give even a cursory view of the belles-lettres in the decline and fall of the Roman empire; but we refer the reader to Schlegel's *History of Literature*, and to Hallam's *Introduction*, &c., for full information on this head. It may, however, be remarked, that during the long period of the middle ages (which has been often, though erroneously, considered as a blank in the history of the human mind), learning was almost wholly confined to the church; and though there was little original genius displayed in the province of imagination, yet here was preserved the germ of the future polite literature of Europe. As early as the fourteenth century, the spirit that had long been slumbering, was reanimated by the genius of Petrarch, and burst forth like a meteor in the Italian republics. Its genial influence was soon felt on this side the Alps; and in the year 1400, as Mr. Hallam observes, Spain, France, England, and Germany were in possession of a national literature. The traces of this spirit, however, were soon obliterated, and its effects gradually swallowed up in the wars that everywhere ensued, and in the all-absorbing taste for metaphysical and theological disquisitions that subsequently prevailed.

It is to the Reformation that the origin of polite literature in modern times may properly be ascribed. Among the first fruits of its effects upon the interests of the belles-lettres in England, it may suffice to mention the names of Spenser, Shakspeare, and Milton, who have embodied in their writings all the riches of the English language, and whose works are of themselves sufficient to furnish any nation with a polite literature of which it might justly be proud.

The close of the last and the dawn of the present century may be regarded as an era in the history of polite literature throughout Europe. [LITERATURE.]

Bellis (Lat.). The Daisy, *Bellis perennis*, is a well-known humble wild flower of the Composite order, and an especial favourite of the poets. There are several garden varieties of this modest flower. One of them has proliferous flower-heads.

Bellona (Lat.). In Mythology, a deity worshipped by the Romans as the goddess of war. She possessed a temple, built and dedicated to her by Appius Claudius, which stood in the Circus Flaminius, near the Porta Carmentalis. It was here that the senate granted audiences to foreign ambassadors, and received generals on their return from abroad. In front of this temple also stood the pillar against which the javelin was hurled, the usual preliminary among the Romans to a declaration of war. The priests of this goddess, who were termed *Bellonarii*, consecrated themselves by incisions in their bodies, and sacrificed to her honour the blood which flowed from their wounds. [ENYO.]

Bellows (Ger. bälgen). A machine contrived to propel air through a tube or orifice, with more or less compression. It is used for blowing fires, supplying the pipes of organs, and other purposes, and is constructed of several forms, but the principle is the same in all of them. The dimensions of the space within which air is confined are contracted; the air, being permitted to escape only at a small opening, rushes out with a velocity proportional to the pressure and to the smallness of the aperture. The large engines for propelling the air to the blast furnaces are the grandest illustrations of this kind of machinery.

Belluae (Lat.). The term by which Linnæus designated an order of Mammalia, nearly corresponding to the Pachyderms of Cuvier.

Belomancy (Gr. βελομαντία). Divination by the flight of arrows, common to various Oriental nations, and especially observed by the Arabians. It has been performed in various modes: one of the most common is, to let fly arrows, with inscriptions on labels attached to them, and take for a guide the contents of that belonging to the arrow first found.

Belonite. The name given by Glocker and Von Kobell to Needle Ore.

Belotes. The edible nuts or acorns of *Quercus Gramuntia.*

Beltane or **Beltin** (said to be the 'fire of Bel' or Belus). May-day, and the traditional Celtic customs attached to it. The month of May is thus called in the present Irish language. This day is particularly celebrated by the herdsmen in the Highlands of Scotland. The Beltane-fire, Beltane-cake, &c. are all observances retained at the present day.

Belts. A name given to the zones or bands which appear on the disk of the planet Jupiter. They are situated near and parallel to the equator of the planet, and are supposed to be produced by clouds in its atmosphere arranged in parallel strata, by currents of wind, which, by reason of the rapid rotation of the planet, must in the equatorial regions blow always in the same direction.

Beluga. The species of whale (*Delphinus leucas*, Pallas) which, from its colour, is commonly called by the whalers 'white-fish.' It is confined to northern latitudes.

Belvedere (Ital. *a fine prospect*). In Architecture, a small building at the top of a house or palace, constructed, as the name implies, to obtain a view of the country.

Belvisiaceae (*Belvisia*, one of the genera). A natural order of monopetalous Exogenous plants related to the *Myrtaceæ*. They are shrubby or arborescent plants, with alternate leaves and axillary almost sessile flowers, remarkable for the concentric rings of stamens. One of the species, *Napoleona imperialis*, comes from tropical Africa.

Bembex (Gr. βέμβιξ). A genus of Hymenopterous aculeate insects of the tribe *Fossores*, or burrowing sand-wasps; raised by Dr. Leech to the rank of a family (*Bembecidæ*), and including the genera *Bembex* proper, *Monedula*, and *Stizus*. Head transverse, with the upper lip exposed; tongue long, legs short; the brachia of the female furnished at the sides with very strong spines for burrowing in the sand. For the habits of this family, see FOSSORES.

Bembidium. A name applied by Latreille to a genus of Coleopterous insects, of the tribe *Carabidæ*. Now raised to the rank of a family (*Bembidiidæ*), including the genera *Lymneum* 1, *Cillenum* 1, *Tachys* 8, *Philochthus* 6, *Ocys* 3, *Peryphus* 16, *Notaphus* 9, *Sopha* 11, *Tachypus* 9, *Bembidium* proper 4. The figures refer to the number of indigenous species in each of the genera. The common characters of the group are, cubits notched, elytra rounded at the extremity, abdomen not pedicellate, external maxillary palpi terminated by a very minute and acute joint, antennæ sub-elongate. The *Bembidiidæ* are generally found in low and damp situations, are of very small size, and glitter with polished metallic colour.

Ben Nuts. The seeds of an Arabian plant called *Moringa aptera*; they yield an oil, called oil of ben, and have been employed in syphilitic diseases.

Ben, Oil of. The expressed oil of the nut of the *Moringa aptera*. This oil is remarkable for not becoming rancid by age; and as it is perfectly insipid and inodorous, it is used for extracting the fragrancy of certain flowers, such as the jasmine, orange, &c. The same tree furnishes the *Lignum nephriticum*, supposed to be useful in certain affections of the kidneys.

Bench. In Surveying, a bench mark is the term applied to a mark showing the starting point of a long line of levels, and to similar marks affixed at convenient distances to permanent objects, to show the exact spot where the level was held.

Bench, Court of Queen's. [COURTS OF JUSTICE.]

Benchers of the Inns of Court. In England are in each Inn a self-elected body, but usually comprising the Queen's Counsel, and some other selected barristers. They exercise the office of admitting students to the bar, and the power of expelling them; subject to appeal to the judges of the superior courts. [BARRISTERS.]

Bend. The curvature given in plan, or in elevation, to the outline of a part, or of the whole of a building, or of a line of road, or a canal. As the name implies, a bend may be either a simple or a compound curve; it may be either on one side only, or it may be an S curve, though the latter would hardly be capable of being executed in a vertical building.

BEND. In Heraldry, an ordinary bounded by parallel lines, equally distant from the line joining the dexter base to the sinister chief. It contains the fifth part of the escutcheon if charged, and the third if not charged. The bend sinister, descending from the sinister chief to the dexter base, is the difference which denotes bastardy, being borne on the paternal escutcheon of the bastard.

BEND. The general Sea term for fastening anything; as to bend one rope to another, the cable to the anchor, a sail to a yard or gaff. Certain knots are called *bends*; as a carrick bend, a fisherman's bend, &c.

Bends or Wales. A certain number of thick planks of the ship's side, from the water upwards.

Benedictine Monks. In Ecclesiastical History, bodies of men living under the monastic rule of St. Benedict. Up to his time the monasteries had been chiefly independent units; Benedict introduced into the monastic life a systematic organisation, and this change was of the utmost importance in the period of barbaric invasions which followed its institution. Benedict's first house was founded at Subiaco early in the 6th century; but the inroads of the Goths compelled him to remove it to Monte Cassino, whence his rule was rapidly extended over Europe. To this order belonged Gregory the Great, and the band of monks who with Augustine at their head were sent by that pope to effect the conversion of England. In later times the order became illustrious for the number of learned men whom it reckoned amongst its members. Bede in England was only the precursor of men (like Lanfranc, Alcuin, Bernard) yet more prominent in the world, whether of theology, politics, or letters. (See Milman, *History of Latin Christianity*, book iii. ch. vi.)

Benefice (Lat. beneficium). A word denoting church preferments of every class, except bishoprics: they may be with or without cure of souls: but the term is usually confined to what are popularly called 'livings,' as distinguished from dignities. Under the Romans, certain grants of lands made to the veteran soldiers were called beneficia; and the same term was applied at the commencement of the feudal system to estates conferred by the sovereign and held under him: which afterwards assuming a hereditary character, became 'fiefs,' properly so called. In the middle ages the popes assumed the power of feudal lords with reference to ecclesiastical 'patronage,' and the term beneficium was hence applied to livings, &c. on the assumption that they were held under the pope as a superior lord. It was the assertion of this claim by Innocent III. and his successors which roused the jealousy of the European sovereigns, especially those of England and France, and led to those long quarrels between the temporal and spiritual power in Europe, which cannot be said to have terminated even in the Reformation.

Benefit of Clergy. In Law, originated in the immunities from municipal jurisdiction enjoyed in many states of Europe by the Roman Catholic clergy during the middle ages. When a person indicted in England for certain offences (such, generally, as subjected the offender to capital or corporal punishment), excepting high treason, pleaded that he was a clerk or clergyman, and claimed privilege, he was 'demanded' by his ordinary: a jury was summoned, and he was tried; and, according to their verdict, delivered to the ordinary as acquit or convict, to undergo canonical purgation, and to be discharged or punished according to the result of such purgation. The proof of clergy, at first strictly required, was at last so relaxed, that it was only necessary for the offender to show that he was able to read. The bishop's commissary was present, to decide whether or not he passed the test satisfactorily. This loose mode of acquiring the privilege was first restricted by the stat. 4 Hen. VII. c. 13, which provided that offenders who had been allowed their clergy should be 'burnt in the thumb,' and if they claimed it a second time, be required to give proof of being actually in orders. By 18 Eliz. c. 7, the second trial by purgation before the ordinary (which had become a mere fiction) was abolished, and the judges were empowered to imprison the person who had benefit of clergy for a year, if they thought proper. By various subsequent statutes, the burning in the hand was commuted for transportation, whipping, &c., at the discretion of the judges; and the benefit was taken away altogether from a number of statutable felonies. By 5 Anne c. 6, the ceremony of reading was abolished, benefit of clergy being granted indiscriminately to all entitled to it; and finally by one of the enactments commonly called Peel's Acts (7 & 8 Geo. IV. c. 28, s. 6) benefit of clergy was abolished altogether.

Benefit Societies. [FRIENDLY SOCIETIES.]

Benevolence. In English History, a species of tax levied by the sovereign. As its name implies, it was nominally a gratuity; but was, in point of fact, exacted as a forced loan, with or without the condition of repayment, under the reigns of the Plantagenet kings. Under a statute of Richard III. benevolences were declared occasionally, by means of circulars under the privy seal, by his successors. By 13 Ch. II. stat. 1, c. 4, no voluntary aid can

be raised on behalf of the king without the authority of parliament; and the general illegality of levying money for the use of the crown without such authority was declared in 1688 by the Bill of Rights.

Bengal Stripes. Cotton cloth woven with coloured stripes. Ginghams.

Benic Acid. One of the solid constituents of *oil of ben*. [Ben, Oil of.]

Benjamin. [Benzoin.]

Bent Grass. A species of *Agrostis*, the bent and creeping stems of which are very difficult to eradicate.

Bent Timber. Of late years much attention has been paid to the subject of bent timber on account of its strength and economy. There are two ways in which this operation is effected; viz. either by bending the timber whole, or by bending it in planks, which are then put together in pieces of any required thickness; both of them have been used for ship and for bridge building. When timber is bent whole, the requisite curvature is given by steaming the plank, and weighting down the side intended to receive the curvature; but the objection to this plan is, that steaming is apt to impair the durability of the wood, and the radius of curvature must be always very flat. It was to avoid these objections that the system was introduced of cutting the logs into planks, and bending them to the required curvature, as in several of the railway bridges and station roofs. In practice, however, it was found that the timber so bent remained sufficiently elastic to admit of considerable movement under the rolling weights of a train, and consequently opened at the joints, and allowed water to act upon the interior. All the bridges where these beams were used have decayed; but in sheltered positions they have stood admirably, provided they were not exposed to any deteriorating effects arising from the deformation under the rolling load. It is to be observed that the bent timber planks retain a much greater degree of elasticity than the whole timber so managed; and that they are also more likely to retain the original strength of the wood itself. Colonel Emy, of the French Génie Militaire, had the merit of introducing the system of bending the planks on the flat, and he published a treatise upon the subject in his work, *Sur la Charpenterie*, to which and to some articles by Nevier in the *Annales des Ponts et Chaussées*, No. 3 of the year 1831, the reader is referred for the mechanical theory of their resistance. Bent timber is largely used in the form of natural grown timber, in shipbuilding; but its use is becoming more and more rare, on account of the difficulty of obtaining natural growth wood for that purpose, which has led to the adoption of other forms.

Bents. The withered stalks of grasses standing in a pasture after the seeds have dropped.

Benzoic Acid. This acid forms a constituent of many balsams; it is generally obtained by heating benzoin, and collecting the acid vapours which are evolved and condensed in brilliant acicular crystals. It is a compound of carbon, hydrogen, and oxygen $= C_{14}H_5O_3HO$. Its combinations are called *Benzoates*.

Benzoic Alcohol. A heavy colourless oil resulting from the action of a spirituous solution of potash on hydride of benzoyl. It bears the same relation to benzoic acid that vinic alcohol does to acetic acid.

Benzoin. The resinous exudation of the *Styrax Benzoin*, a tree which is a native of Sumatra. Benzoin is a combination of resin and *benzoic acid*. It has a mottled or amygdaloid texture, and is composed of a mixture of brown and white parts. It has a fragrant odour.

Benzoin. A genus of *Lauraceæ* found in India and North America. *B. odoriferum*, a deciduous bush of North America, furnishes an aromatic stimulant tonic bark; and its berries yield an aromatic oil. This plant has been known as *Laurus Benzoin*.

Benzole. A compound of carbon and hydrogen, originally discovered by Faraday amongst the products of the destructive distillation of whale oil. The same compound was produced by Mitscherlich from *Benzoic acid*. It consists of 12 atoms of carbon, combined with 6 of hydrogen, and may be considered to be the hydride of the radical phenyl ($C_{12}H_5 + H$). It has a peculiar aromatic odour, boils at 176°, and concretes into a crystalline solid at 32°, a property which enables it to be separated from other hydrocarbons, which remain liquid at low temperatures. Benzole occurs amongst the products of the distillation of coal tar. One, two, or three atoms of hydrogen in benzole may be replaced by bromine, chlorine or peroxide of nitrogen. Nitrobenzole is now largely used as a source of aniline in the preparation of the so-called coal-tar colours.

Benzophenone. A combination of the radicals benzoyl and phenyl. It is crystalline, and is produced on distilling benzoate of lime with quicklime.

Benzoyl or Benzule (from benzoin, and ὕλη, *matter*). A compound of carbon, hydrogen, and oxygen, $= C_{14}H_5O_2$, regarded as the base of benzoic acid; but the term is more appropriately applied to the radical hydrocarbon, $C_{14}H_5$.

Beraunite. A hydrated phosphate of peroxide of iron, occurring foliated and radiated, of a hyacinth-red or reddish-brown colour, at Huel Jane in Cornwall, in scaly, brittle masses; and near Beraun in Bohemia.

Berberidaceæ. A natural order of thalamifloral polypetalous Exogenous plants, named after *Berberis* or Berbery, which is in fact the most important genus it contains.

Berberine. A yellow bitter principle, contained in the alcoholic extract of the root of the berbery tree.

Berbery (Lat. berberis). A spiny shrub, bearing yellow flowers, and succulent one-celled edible fruit, growing in racemes. It is one of a genus in which the fruit is universally fleshy

and acid, although often less so than in the common kind, *Berberis vulgaris*. Some of the species have pinnated leaves, many are evergreens, and several have purplish-black fruit; even the common sort has a variety of this description, as well as others with pale yellow and stoneless fruit. There is an idea among country people that a berbery bush brings blight to a wheat field; but the parasitical fungus which attacks the berbery is altogether different from that which produces the mildew of wheat. The species with pinnated leaves have been called *Mahonia*.

Berengelite or **Berengela Resin.** A bituminous mineral allied to Guyaquillite, found in amorphous masses of considerable extent, forming a sort of lake, in the province of St. Juan de Berengela in Peru, like the pitch-lake of Trinidad.

Bergamot, Essence of. The essential oil of the rind of a small pear-shaped fruit, the produce of the *Citrus Limetta Bergamium*. It is much used as a perfume, and apt to be adulterated with the oils of orange and lemon peel, and with alcohol.

Bergaptene. A solid body occurring as a deposit in oil of bergamot.

Bergmannite. A brick-red or greyish-white fibrous variety of Mesotype occurring massive in Zircon-Syenite near Brevig in Norway. Named after the German chemist Bergmann.

Berlin Blue. [PRUSSIAN BLUE.]

Berm (Fr.). In Fortification, a narrow level space, two or three feet wide, along the exterior slope of a parapet, to prevent the mass of earth and other materials of which it is composed from falling into the ditch.

Bernoulli's Numbers. A series of numbers first used by James Bernoulli, Professor of Mathematics at Basle (1687). In the theory of algebraical series they are of great importance, are usually represented by the letters B_1, B_3, B_5, B_7, &c., and have the values $\frac{1}{6}$, $\frac{1}{30}$, $\frac{1}{42}$, $\frac{1}{30}$, &c., the general, or n^{th} Bernoullian number, B_{2n-1}, being the coefficient of $(-1)^{n+1}\frac{t^{2n-1}}{1.2\ldots 2n-1}$ in the developement of $(e^t-1)^{-1}$. The theory of these numbers will be found in the works of Euler and Lacroix on *The Differential Calculus*. The values of the first twenty-five of them are given in the *Penny Cyclopædia* (art. 'Numbers of Bernoulli').

Berosus. In Entomology, a genus of Coleopterous insects of the family *Hydrophilidæ*. They inhabit ponds, in which they may often be seen swimming in an inverted position.

Berries of Avignon (*Graines d'Avignon*). The fruit of the *Rhamnus infectorius*, generally known under the name of *Persian Berries*. They are grown in Provence, Languedoc, and Dauphiné, and another variety comes from Persia. They contain a peculiar principle which has been termed *Rhamnine*, and which acquires a yellow colour by exposure to air.

Berthierite. A double sulphide of antimony and iron found in indistinct elongated prisms or confusedly lamellar masses, of a dark steel-grey colour, near Padstow in Cornwall; also in Auvergne, the Vosges, Saxony, and Hungary. Named after Berthier, by whom it was originally discovered.

Bertholletia (named in memory of Berthollet). A genus of *Lecythidaceæ*, one species of which, the *B. excelsa* of botanists, produces what are commonly called Brazil nuts. It is one of the largest trees of South American forests. The hard-shelled fruit is roundish and about six inches in diameter, and contains about two dozen of elongated wrinkled triangular seeds which are the 'nuts' of the shops. These are imported in considerable quantities from Para, and are hence sometimes called Para nuts. The seeds yield by pressure a bland oil, used by watchmakers and artists.

Beryl (Lat. beryllus, Gr. βήρυλλος). A variety of Emerald. The crystals (six-sided prisms of very variable dimensions, but usually much larger than those of the Emerald) are generally blue or yellow, but some are colourless. When of clear tints of sea-green or sky-blue, they are called by the jewellers *aqua-marines*. The Beryl is one of the few minerals which contain the earth *glucina*, and consists of 67 per cent. of silica, 19 of alumina, and 14 of glucina. Gigantic crystals are met with in North America at Acworth and Grafton in New Hampshire, and at Royalston in Massachusetts. Very fine crystals are also brought from Dauria on the frontiers of China, from Siberia, and Brazil. In Britain, Beryls are found in Cornwall at St. Michael's Mount, in small bluish crystals in the parishes of Mabe and Constantine, and amorphous at Huel Cock near St. Just. In Ireland very fine specimens, mostly of a fine blue colour and sometimes quite transparent, are met with in the Mourne Mountains, county Down, and in other localities in the counties of Dublin and Wicklow; in Scotland they occur in the granite and gneiss of Cairngorm, and in the primary limestone of Portsoy in Banffshire, Kinloch Rannoch, Mount Baltoch near Braemar, &c.

Berzelianite. A selenide of copper of a silver-white colour and metallic lustre, generally found in minute seams traversing Calc Spar, or as dendritic delineations of a black colour, owing to the decomposition it undergoes from exposure to the air. It occurs in the copper mine of Scrickerum in Sweden, and near Lehrbach in the Harz. Named after the Swedish chemist, Berzelius.

Berzeliite or **Berzelite.** Magnesian Pharmacolite. [KÜHNITE.]

Berzeline. A mineral, with nearly the same composition as Leucite, found massive, and in extremely minute octahedral crystals, which are white, grey, or colourless, and have a vitreous lustre, in peperino near Rome, and also at Galloro, near La Riccia, in an augitic rock. Named after Berzelius.

Besimen. An obsolete term for the spores or seeds of the lowest kinds of plants, especially of *Algæ*.

Beta (Celt. bett, *red*). The chenopodiaceous genus which comprises the Beet, Mangold Wurzel, &c. [BEET.]

Betel. The leaf of the Betel or Siriboa Pepper, which is chewed by the inhabitants of many parts of India, along with a nut of the areca palm tree and lime. This mixture is acrid and narcotic, and stains the saliva red. The fruits of *Areca Catechu* are called Betel nuts.

Bethylus. In Entomology, a genus of Hymenopterous insects of the family *Proctotrupidæ*.

Béton. The French name for Concrete; but as the concrete so made is essentially different from the stuff made under that name by English builders, it may be as well to retain the distinction in names, and to express by the latter the English concrete, and by the former the French béton. This consists, then, of an hydraulic lime properly slaked by itself, and presented in that state to the sand, so that the process of hydration may commence before it is mixed with the ballast which is subsequently added, by being turned over with the mortar on a boarded floor, and then run into the trench and well rammed. In fact, the object of concrete-making being to prepare a rough description of masonry composed of ballast and mortar, this method of making it must be the most efficacious, especially when the material has to be applied under water. In this case it may often happen that special precautions are required for conveying the béton to its intended position, because the lime may become detached from the other elements in its passage through the water. To prevent this, closed boxes are used, which are only opened when the mixture reaches its destination. The quantity of lime required for the preparation of a béton may vary with the circumstances of its use, from one of lime to 2½ or 3 of sand, mixed with one proportion of mortar to three of ballast; evidently the quality of the lime has much to do with the proportions, and it is thus that they are made to vary. [CONCRETE; LIME.]

Betrothment (A.-Sax. troth, *truth*). A mutual compact between two parties, by which they bind themselves to marry. Betrothment was a legal contract by the Roman law, as it now is in various continental countries. In Germany, betrothments are either public, with the consent of relations and presence of witnesses; or private (clandestine), which in some countries are void; in others, although valid as contracts, punishable as misdemeanours. Public betrothment induces (where it is recognised as a legal ceremony) the obligation to marry. But according to modern practice an action for damages is almost the only way of enforcing it; a small fine or imprisonment being the utmost criminal penalty for the violation of the engagement.

Betulaceæ (*Betula*, one of the genera). A small natural order of catkin-bearing monochlamydeous plants, containing the Birch, after which it takes its name, and also the Alder. The order formed part of what were formerly called *Amentaceæ*, or catkin-bearers.

Betuline. A resin contained in birch bark.

Beudantite. A hydrous silicate of lead and peroxide of iron with phosphate of peroxide of iron. It occurs in small black and brown rhombohedrons at Horrhausen and Montabaur (Dernbach), in the district of Nassau on the Rhine, and at the Glendore iron mine, near Cork. The crystals from the first locality have the phosphoric acid almost wholly replaced by arsenic acid. Named after Beudant, the French mineralogist.

Bevel (Fr. beveau). In Architecture, an instrument designed to take angles. One side of a solid body is said to be bevelled with respect to another, when the angle contained between their two sides is greater, or less, than a right angle. The term *splay* is nearly synonymous with *bevel*; but it is applied to openings which have their vertical sides sloped for the purpose of enlarging the opening.

Bevel Angle. A term used among artificers to denote an angle which is neither a right angle nor half a right angle.

Bevel Gear. In Mechanics, a species of wheel work, in which the axes of two wheels, working into each other, are neither parallel nor perpendicular, but inclined to one another at a certain angle. Wheels of this description are also called conical wheels, because their teeth may be regarded as cut in the frustrum of a cone. [WHEEL.]

Bey or **Beg.** A Turkish and Tartar title of dignity, used with no very accurate application for lord, prince, or chief, and frequently subjoined to the proper names of persons of rank.

Bezant. A gold coin struck at Byzantium (Constantinople): it varied in weight and in value. Bezants appear to have been current in England from the tenth century to the time of Edward III. Some of them weighed about twenty grains. According to Camden, a piece of gold which was anciently offered by the king on high festivals was called a *bizantine* and valued at 15*l*. There were also white or silver bezants.

BEZANT. In Heraldry, a circle, or. The name is derived from the gold coin. It was probably introduced into coat armour by the Crusaders.

Bezoar. A Persian word denoting poison, and applied to certain intestinal concretions of animals, called bezoar-stones, which are supposed to possess poisonous powers.

Bezoar Mineral. An old preparation of oxide of antimony.

Bezoutiant. A term first employed by Sylvester (*Phil. Trans.* 1853, and *Phil. Mag.* vol. vi. 1853) to denote the n-ary quadric whose discriminant is the symmetrical determinant obtained by eliminating, according to Bezout's abridged method [ELIMINATION], the variables from two binary quantics of the same degree (n). The ($n-1$)-ary quadric whose discriminant coincides with that of a given binary

n-ic is also sometimes called the Bezoutiant of the given quantic, though Sylvester referred to it as the Bezoutoid. (Salmon's *Higher Algebra.*)

Bezoutics. [ELIMINATION.]

Bi (Lat. bis, *twice*). Signifies, when attached to other words, two, twice, or double; as bicarbonate of potash, a compound of potash with two atoms of carbonic acid; bilocular, two cells; bivalve, two valves, &c.

Biarticulate (Lat. bis, *two*, and articulus, *joint*). Applied in Entomology to the antennæ of insects when they consist of but two joints, and also to the abdomen under the same circumstances, as in the *Nycteribia biarticulata.*

Biauriculate (Lat. bis, and auricula, *an auricle*). In Comparative Anatomy, signifies a heart with two auricles, as in most bivalve molluscs, and in all reptiles, birds and mammals.

Bibbs. In Naval language, are brackets bolted to the masts for the purpose of supporting the cross-trees.

Bible (Gr. τὰ βιβλία). The volume containing the collected books of the Old and New Testaments. The Greek word in primitive use was ἡ γραφή, or τὰ ἱερὰ γράμματα; and τὰ βιβλία is not found till the fifth century. St. Jerome (circa 400) gives the name *Biblia* to his Latin version of the Scriptures; and it is from the Latin that the word *Bible* has been introduced into our language. It occurs in Piers Ploughman and Chaucer; and being adopted by Wiclif, it has been ever since strictly confined to the sacred volume.

Bible Society, British and Foreign. [SOCIETIES.]

Biblical History and Literature. The accounts of the books of the Jewish Scriptures antecedent to the captivity are few and indistinct; but they are referred to under the titles of 'the law,' 'the books of Moses,' and 'the books of the law of Moses,' by Daniel (ix. 11), Ezra (vi. 18), and Nehemiah (viii. 1): there are also other passages from which it may be inferred, independent of the internal evidence of the books which we possess, that there existed such from an early period.

The canon of the Old Testament appears, however, to have been settled about fifty years after the return from the captivity, by the authority of Ezra and the prophets of his day: the books of Nehemiah, Malachi, and Ezra himself being subsequently added. The sacred writings which came in later times to be incorporated in the collection of the Jewish Scriptures are known by the name of Apocrypha, or secret: they were undoubtedly held in respect by the Jews, and by the Christians afterwards; but Protestants deny that their authority was ever placed on the same footing as that of the canonical Scriptures.

At a later period we find passages in the New Testament, in Philo, and most distinctly in Josephus, to prove the fact of this collection of the Scriptures into a volume. The books themselves are first specified by Origen, who enumerates twenty-two, in which number he coincides with Josephus. His list embraces all that we consider canonical, and rejects the Apocrypha.

The early versions which illustrate the question of the antiquity of the Hebrew Scriptures are the Samaritan Pentateuch, and the Septuagint or Greek translation. It is not to be supposed that the Samaritans would have adopted and translated the books of the Jews, unless they had been received prior to the separation and enmity of the two peoples, the period at latest of the return from the captivity. The Samaritan Pentateuch now extant is said to be a version from the earlier Hebrew Samaritan into the more modern Samaritan, and was made before the time of Origen. The part of the Septuagint which comprises the Pentateuch was made about the year B.C. 285; the translation of the other books into Hellenistic Greek appears to be of different and somewhat later dates.

Next in order to these may be mentioned the versions of the Old Testament in the earliest periods of Christianity, which are important, not as assisting us to ascertain the antiquity of the original, but as contributing to our knowledge of the genuine text. These may be divided into three classes.

I. The Oriental, comprising:—
- The Syriac or Peschito (literal), from the Hebrew, about the end of the first century—embracing both the Old and New Testaments.
- The Coptic, from the Septuagint—between centuries two and five. This embraces also the New Testament.
- The Ethiopic, from the Septuagint—in the fourth century: embraces the New Test.

II. The Latin, or Western:—
- The Italic, from the Septuagint, in either the first or second century; only fragments remain: it embraced also the New Testament.
- The Vulgate, made from the Hebrew by Jerome, A.D. 390. This translation is considered an ultimate authority by the church of Rome.
- The Gothic Version of Ulphilas, which was made from the Greek of both the Old and New Testaments, in the fourth century, has not come down to us entire. Only a small part is in print.

III. The Greek, comprising:—
- The version of Aquila.
- —— of Theodotion.
- —— of Symmachus.
- All translated from the Hebrew; all of or near the second century; all exist only in the fragments of the Hexapla or combination of six versions by Origen.

The genuineness of the Hebrew text was preserved after the destruction of Jerusalem by the sedulous care of learned academies which flourished at Tiberias, Babylon, and other places, from the first to the twelfth centuries. The date of the Masora is generally fixed about the fifth century. This work consisted of a most

minute enumeration of the sections, verses, words, and letters of the Scriptures; which has been so successful in fixing the genuine reading, that although there were discovered upwards of 800 discrepancies between the Oriental and Occidental Recensions, they all relate, with one single exception, to vowel points, and are of no kind of importance. For an account of the labours of the early Jewish schools of criticism in the interpretation of the Hebrew text, see TALMUD.

The integrity of the text of the New Testament has been established by the collation, wholly or in part, of 674 manuscripts existing either entire or in fragments. These have been classified by modern critics according to recensions or families, the most simple of whose systems, and the most approved, is that of Scholz, who considers all the variations that exist in these MSS. to be resolvable into their having been transcribed from Constantinopolitan or Alexandrian exemplars. The former he considers to have been from the earliest times the most strict and faithful recension. It was that which was principally used in the liturgical offices of the East; and its fidelity is argued from the exact uniformity of all the MSS. which can be traced historically to a Constantinopolitan origin. This may be accounted for by the authority inherent in the text received in the centre of the imperial power and of the patriarchal jurisdiction. It is also consistent with the minute care with which the rites of the Constantinopolitan church were enjoined by its missionaries upon their converts; and also with the character of the Greek fathers, who present much greater exactness and uniformity in their quotations of the New Testament than the African. On the other hand, the Alexandrian copies have been written with a considerable degree of carelessness, and do not appear to have been intended, even in their own country, for reading in public service. They are said to exhibit the rash and speculative spirit of the theologians of the Alexandrian church. The former of these recensions has been adopted in the Syriac, Gothic, and Slavonic versions. It is that also which forms the basis of our modern texts. The latter was followed by several Latin, the Coptic, and Ethiopic translations. Erasmus conceived the idea of the Greek text having been purposely corrupted to suit the Vulgate, and assigns the council of Florence in 1439 as the authority by which this transaction was effected. This opinion continued to be held under the title of the Fœdus cum Græcis, with more or less discussion till modern times, by which it seems to be very generally rejected as untenable. It is known, on the contrary, that in the compilation of his translation, which bears the name of the Vulgate, the existing Latin version was corrected by Jerome from the Greek.

Bibliography (Gr. βιβλιογραφία). The science of books. The knowledge which is required to classify books, according to the various subjects on which they treat, has been termed intellectual bibliography; that of the external peculiarities of books—the number of editions through which they have passed, the printer or publisher, their date as to time and place, their form and size, and their comparative completeness, correctness, typographical beauty, and rarity — material bibliography. The first branch borders closely on the province of criticism; for the most valuable bibliographical works, being what are termed in French 'catalogues raisonnés,' are those in which the lists of books are accompanied with some remarks on the character of their contents. The best 'catalogue raisonné' is, perhaps, that of the French *Bibliothèque Royale*, 10 vols. folio, 1739—1753. The catalogue of the library of the University of Göttingen is said to be the most complete of this kind, but we believe it is still in MS. The catalogue of the library of the Writers to the Signet in Edinburgh is the best English 'catalogue raisonné.' It is arranged upon De Bure's plan, and was published in 1805, in 4to. The second branch of bibliography has been of late years cultivated with all the ardour attached to a fashionable and somewhat eccentric pursuit. The lovers of rare editions and curious copies of works, from being, to borrow a French term, 'bibliophiles,' formed some years ago a peculiar sect entitled 'bibliomaniacs,' with whom the fancy for books had become a passion, like those of Dutch speculators for tulips and pictures. Many works of novel and curious research in this department of literature have been recently produced to guide their taste, and gratify their appetite.

The following list contains a selection from among the most valuable works which we possess, in different departments of bibliography. But many of them, from the critical matter which they contain, may be considered to belong to the history of literature, as well as of books and editions.

I. *Introductory Works on the Science of Bibliography.*

Peignot, Manuel Bibliographique, 8vo. Paris, 1800.

Peignot, Dictionnaire Raisonné de Bibliologie, 3 vols. 8vo. Paris, 1804. An excellent work on the science.

Achard, Cours de Bibliographie, 3 vols. 8vo. Marseille, 1807. Not very methodically arranged.

Horne, Thomas Hartwell, Introduction to the Study of Bibliography, 2 vols. 8vo. Lond. 1814.

Denis, Einleitung zur Bücherkunde, 2 vols. 4to. Vienna, 1777, 1778; 2nd edit. 2 vols. 4to. Vienna, 1795.

Boulard, Traité Élémentaire de Bibliographie.

II. *Bibliography of the Oriental and Classical Languages.*

Gesner, Bibliotheca Universalis, sive Catalogus Scriptorum Lat. Gr. et Hebr. tam extantium

quam non extantium. Folio, Tigur. 1545. The best edition is that of Frisius, folio, Tigur. 1583. The works are arranged according to the names of the authors. It is mainly confined to works in the Hebrew, Greek, and Latin languages. It was one of the earliest attempts at classical and Hebrew bibliography.

Clarke, Dr. Adam, Bibliographical Dictionary, 6 vols. 12mo. Liverpool and Manchester, 1802-4. See also his Bibliographical Miscellany, 2 vols. 12mo. Lond. 1806.

Long, James le, Bibliotheca Sacra, 2 vols. 8vo. Paris, 1709. An enlarged edition was published by Desmollts in 2 vols. folio. Paris, 1723. Another edition was begun by Masch in 1778, and between that and 1790 5 vols. 4to. were published, but the work was unfinished.

Fabricius, Bibliotheca Græca, edited by Harles, 12 tom. 4to. Hamburg, 1790, 1809.

Fabricius, Bibliotheca Latina. By Ernesti. 3 vols. 8vo. Lips. 1773, 1774.

Fabricius, Bibliotheca mediæ et infimæ Latinitatis. By Mansio. 3 vols. 4to. Batav. 1759.

Harwood's View of the various Editions of the Greek and Roman Classics, 4th edit. (the best) 12mo. Lond. 1790.

Dibdin's Introduction to the Knowledge of rare and valuable Editions of the Greek and Latin Classics, 2 vols. 8vo. 1827.

Moss's Manual of Classical Bibliography, 2 vols. 8vo. 1825.

Degli Autori Classici Biblioteca portabile (Boni and Gamba), 2 vols. 12mo. Venice, 1793.

III. *Bibliography of Particular Sciences and Branches of Literature.*

Lipenius, Bibliothecæ (Theologica, Juridica, Philosophica, Medica), 6 vols. fol. The Juridica by itself has been reprinted, with supplements, &c. in 4 vols. Leipsic, 1775–89. The whole collection passes under the title of Bibliotheca Realis.

Meusel, Leitfaden zur Geschichte, &c., 2 vols. 8vo. Leipsic, 1799.

Bibliothèque Historique de la France, 5 vols. folio, 1768, 1778.

Murhard, Bibliotheca Mathematica, 5 vols. 1797-1805.

Dryander, Catalogus Bibliothecæ Historico-Naturalis Josephi Banks (a general account of books on natural history), 5 vols. 8vo. Lond. 1796-1800. This valuable library is now in the British Museum. The catalogue was compiled with great ability.

Lalande, Bibliographie Astronomique, 4to. Paris, 1803.

Boucher de la Richarderie, Bibliothèque de Voyages, 6 vols. 8vo. Paris, 1808.

IV. *Bibliographical Works on Rare Books, Typographical Antiquities, Early Editions, &c.*

Vogt, Catalogus Historico-Criticus Librorum rariorum, &c., 8vo. Hamb. 1732. The 5th, and best edition, 8vo. Nuremb. 1793. A very valuable work.

Gerdesius, Florilegium Librorum rariorum, 3rd and best edition, 8vo. Groning. et Brem. 1763.

Clement, Bibliothèque curieuse, ou Catalogue Raisonné des Livres rares, 9 vols. 4to. 1750–60. A minutely critical work.

Bauer or *Baverus*, Bibliotheca Librorum rariorum universalis, 7 vols. 8vo. Nuremb. 1770–91.

Maittaire, Annales Typographici ab Artis inventæ Origine ad Annum MDLXIV. 5 vols. 4to. Hag. Com. Amstelod. et Londini. 1719–41. Several supplements have been published.

Panzer, Annales Typographici ab Artis inventæ Origine ad Annum MD., &c., 11 vols. 4to. Nuremb. 1793–1803. It is carried down to 1536. It is a work of the very first importance, but is rendered more complete by a subsequent work of his, published in German, called Annals of Ancient German Literature, &c., 2 vols. 4to. Nuremb. 1788, 1806. A supplement to vol. i. was published in 1802.

Ames's Typographical Antiquities, first edition, 1749; republished by W. Herbert in 3 vols. 4to. 1790; and again by Dr. Dibdin in 4 vols. 4to. 1810–19.

Dibdin, Bibliotheca Spenceriana (a catalogue of books in the Spencer library, printed before 1500), 4 vols. imp. 8vo. (and 55 copies in 4to.). Lond. 1814–15. Well known, like most of the other works of this distinguished bibliographer, for the minuteness of its research and extreme beauty of embellishment.

Santander, Dictionnaire Bibliographique Choisi du Quinzième Siècle, 3 vols. 8vo. Bruxelles, An. XIII., 1805.

De Bure, Bibliographie Instructive, ou Traité de la Connaissance des Livres rares et singuliers, with supplements, in all 10 vols. 8vo. Paris, 1763, 1782. The most practically useful and elegant work on the subject, and one which has perhaps contributed more than any other to make the study of bibliography popular.

Osmont, Dictionnaire des Livres rares, 2 vols. 8vo. Paris, 1768.

Renouard, Annales de l'Imprimerie des Aldes, ou Histoire des Trois Manuce, &c., 2 tom. 8vo. Paris, 1803. [ALDINE EDITIONS.]

Lowndes, Bibliographer's Manual. New edition by Bohn. A valuable work.

V. *General Bibliographies, and Miscellaneous Works.*

Watt's Bibliotheca Britannica, 4 vols. 4to. Edin. 1824. This most useful and meritorious work contains a catalogue of works, arranged alphabetically, first under the head of writers, and then of subjects. It contains many foreign articles, but is chiefly devoted to English literature. A more complete and more critical work on English bibliography is

among the greatest desiderata of the present day.

Querard, La France Littéraire. A very valuable catalogue of French works, in all departments of literature. Paris, 1828, &c.

Mazzuchelli, Gli Scrittori d' Italia, cioè Notitie Storiche e Critiche intorno alle Vite e agli Scritti dei Litterati Italiani. A work containing literary history and biography, with bibliographical science, 6 vols. fol. Brescia, 1753–63.

Potthast, August. Bibliotheca Historica Medii Ævi. Wegweiser durch die Geschichtswerke des Europäischen Mittelatlers von 375—1500. Berlin, 1862. A very valuable work for the student of mediæval history.

Foppens, Bibliotheca Belgica, 2 vols. 4to. Brux. 1739.

Dictionnaire Bibliographique, 3 vols. 8vo. Paris, 1790.

Brunet, Manuel du Libraire, &c., 3rd and enlarged edition, 4 vols. 8vo. 1820. The best work on bibliography. A new edition is in course of publication (1863). Two supplementary volumes were published in 1832.

Morhof, Polyhistor, Literarius, Philosophicus, et Practicus, first edition by Fabricius, 2 vols. 4to. Lubec, 1747. This is the best edition.

Saxius, Onomasticon Literarium, 7 vols. 8vo. Traj. ad Rh. 1775–90, and a supplementary volume in 1803.

Jöcher's German Dictionary is a useful work, and contains many works and authors unnoticed by other bibliographers; but the Bücher-Lexicon of Hensius, and that of Kayser, are the most complete modern compilations of this order.

Sotheby, Principia Typographica. Only two of the elements of bibliography discussed by him have been published, viz. Block Books and Paper Marks. The remainder of a labour of forty years is unfortunately still in MS.

Rich, O., Bibliotheca Americana nova; or, A Catalogue of Books in various Languages, relating to America, printed since the year 1700, in 2 vols. Vol. i. 1700—1800; vol. ii. 1801—1844. Lond. 8vo. 1835, 1846. There is a supplement to vol. i. dated 1841.

Duyckinck, Evert O., and *George L. Duyckinck*, Cyclopædia of American Literature, embracing personal and critical Notices of Authors, and Selections from their Writings, from the earliest Period to the present Day, with Portraits, Autographs, and other Illustrations, in 2 vols. imp. 8vo. New York, 1855.

Allibone, S. Austin, A Critical Dictionary of English Literature, and British and American Authors, living and deceased, from the earliest Accounts to the middle of the Nineteenth Century, containing 30,000 Biographies and Literary Notices, with 40 Indexes of Subjects, imp. 8vo. Philadelphia and London, 1859. Only vol. i., A to J, yet published.

VI. *Bibliography of Anonymous Works, and of Books privately printed.*

Barbier's Dictionnaire des Ouvrages Anonymes et Pseudonymes, 4 vols. 8vo. 1822–25. Confined to works in the French and Latin languages.

Martin's Bibliographical Catalogue of Books privately printed, 8vo. 1834. A second edition of this valuable work has been published.

Bicalcarate (Lat. bis, and calcar, *a spur*). When a limb or part is armed with two spurs.

Bice. In Painting, a light blue colour prepared from smalt. From it, by a mixture with yellow orpiment, another colour is formed of a green hue, bearing the same name.

Biceps (Lat. from bis, and caput, *head*). When muscles have a double insertion, or arise by two heads.

Bicolligate (Lat. bis, and colligo, *I bind together*). In Ornithology, a term signifying the connection of all the anterior toes by a basal web.

Bicolor (Lat.). When an animal or part is of two colours.

Bicornis (Lat. from bis, and cornu, *a horn*). In Zoology, when an animal or part has two horns, or two hornlike processes. In Anatomy, when the uterus has two divisions, like horns, as in most quadrupeds.

Bicuspid (Lat. bis, and cuspis, *a point*). In Anatomy, when a part has two cusps, or pointed portions, as the bicuspid valve between the left auricle and ventricle. The term is also applied to a tooth with two points.

Bidentate (Lat. bis, and dens, *a tooth*). When an animal has but two teeth, as the *Delphinus bidens*; or when a part has two tooth-like processes.

Bieberite. A hydrated sulphate of cobalt and magnesia, which occurs in flesh-red and rose-coloured, translucent, friable stalactites, and in crusts investing other minerals, in the rubbish of old mines at Bieber near Hanau, and at Leogang near Salzburg.

Biennial (Lat. biennis, *of two years' duration*). A term applied to plants which grow one year and flower the next, after which they perish; they only differ from annuals in requiring a longer period to fruit in. Most biennials, if sown early in the spring, will flower in the autumn, and then perish, thus actually becoming annuals.

Biesting, Beestning or **Colostrum.** The first milk yielded by the cow immediately after the birth of the calf.

Bifarious (Lat. bifarius). Arranged in two rows; frequently applied to flowers and ovules.

Biforate (Lat. biforis). Having two perforations or apertures, as the anthers of a *Rhododendron.*

Biforines (Lat. biforis). Minute oval sacs found in the interior of the leaves of some Araceous plants. They taper to each end, where they are perforated, and are apparently composed of two bags one within the other, the

inner bag being filled with the fine acicular crystals or spiculæ called raphides. When the biforine is placed in water it discharges its spiculæ with considerable violence, first from one end and then from another, recoiling at every discharge, and eventually emptying itself, when it becomes a flaccid motionless bag.

Bifurcate (Lat. bis, and furca, *a fork*). When a part has two prongs like a fork.

Big or **Bigg** (Dan. byg), also called **Bere.** The name applied in Scotland to Hordeum Hexastichon. It is a much hardier plant than barley, to which it is preferred in Scotland, as ripening more rapidly.

Bigamy (Lat. bis, and Gr. γάμος, *marriage*). The offence of contracting a second marriage during the life of the husband or wife, which, by the law of England, is felony, punishable by penal servitude, or imprisonment. Bigamy, by the canon law, signified a second marriage after the death of the first wife, or a marriage with a widow; and incapacitated the party contracting it from entering holy orders in the event of widowhood. [MARRIAGE, LAW OF.]

Bight (A.-Sax. biht). Part of a rope between the ends; bight is also a shallow bay or hollow in the line of sea coast.

Bignoniaceæ (from Bignonia, the typical genus: so called after the Abbé Bignon, a French man of letters, and the friend of Tournefort). A natural order of corollifloral didynamous Exogens, usually having a twining stem, large trumpet-shaped flowers, and a pod-like capsule with winged seeds. Some of them are trees of considerable size, and furnish timber valuable in the countries where it is produced; but the greater part are interesting only for the beauty of their flowers, in which respect this order yields to no other; indeed the *Bignonias* are probably the handsomest twining plants known. *Bignonia Chica* yields a red pigment, called Chica on the Orinoko, and much used by the natives for painting their bodies.

Biharite. The name proposed by Peters (after the mountain in which it is found) for a mineral from Werkstahl, near Retzbranya, which had previously passed for Agalmatolite.

Bijugate (Lat. bis, and jugum, *a yoke*). Composed of two pairs of any thing; a term applied to leaves pinnated with two pairs of leaflets.

Bikh, Bish or **Bikhma.** The root of a deleterious plant inhabiting Nepal. It was used by the natives of that country to poison their wells when the British troops invaded it. This plant is the *Aconitum ferox*, the poison of which, like that of all other Ranunculaceous plants, is volatile; and although highly dangerous when fresh, loses its activity when exposed to the air.

Bilabiate (Lat. bis, and labium, *a lip*). When a flower has all or any of its parts collected into two separate parcels or lips. Thus a calyx having two of its sepals collected into one parcel, and the others into a second parcel, or a corolla with its five petals adhering two and three together, is bilabiate.

Bilamellate (Lat. bis, and lamella, *a plate*). When a part is divided longitudinally into two lamellæ or plates; also, bearing two vertical plates.

Bilander (Fr. bélandre, Dutch bij-lander). An obsolete two-masted cargo vessel, remarkable for bearing her mainsail bent to the whole length of a yard passing fore and aft at an angle of 45° with the deck.

Bilberry. A small bush inhabiting the northern parts of Europe in mountainous situations, and bearing small black berries, which are eaten by country people under the names of whorts, hurts, &c., and are a favourite food of deer. It is the *Vaccinium Myrtillus* of botanists.

Bilboes. Long bars of iron, with shackles sliding on them, into which are placed the ankles of sailors who may be sentenced to be 'put in irons.'

Bildstein (Ger.). A mineral composed chiefly of silica and alumina with a little oxide of iron. [AGALMATOLITE.]

Bile (Lat. bilis). A fluid secreted in the liver, of a yellow colour and a nauseous taste, compounded of sweet and bitter; it sinks in water, and mixes with it in all proportions; it is slightly alkaline, and feels soapy. It contains a peculiar bitter principle, which has been called *picromel*, and a little free soda and saline matters. According to Berzelius, the solid constituents of bile amount to about one-tenth of its weight.

Bilge. The lower or flat part of the bottom of a ship on which she rests when aground. Mr. Wedgwood regards the word as connected with Bulge (*Dictionary of English Etymology*).

BILGE OF A CASK. The middle part between the ends, in which the bung-hole is placed.

Bilge Water. The water that collects in the bottom of a ship by leakage or otherwise. It has usually a peculiar and offensive smell. When a ship is tight, the bilge water when pumped up is dark; in a leaky ship, it comes up clear.

Bilged. In Nautical phrase, having the bottom stove in.

Bilgeways. Timbers which are employed in the launching of ships.

Biliary Calculi. Concretions which form in the gall-bladder (gall stones) or bile-ducts. They are generally composed of a peculiar crystalline fatty matter, which has been called *cholesterine*.

Bilifulvin. The yellow colouring matter of bile.

Biliphein. The brown colouring matter of bile, to which the colour of excrement is due.

Biliverdin. The green colouring matter of ox-bile.

Bill (Lat. bulla, the seal appended to a papal document or bull). A legislative measure introduced into parliament is so called until it has acquired the force of law by receiving the royal assent. Bills are either public or private; a distinction founded rather on usage and precedent, than on any exact definition. The immediate parliamentary consequence of the

distinction is the payment of certain fees to the officers of the house, which are due by custom on private bills. According to Hatsell, this difference between private and public bills was recognised as long ago as 1607. It is a general rule of parliamentary proceeding, that the same bill or question cannot be twice offered in the same session. But at every stage of a bill, the whole of it is supposed to be before the house; and consequently if words have been inserted by way of amendment, the sense of the house may again be taken respecting them at a subsequent stage. [PARLIAMENT.]

Bill in Equity. In Law, is the proceeding whereby a suit in Chancery is commenced, being in the form of a petition addressed to the Lord Chancellor.

Bill of Exchange. [EXCHANGE.]

Bill of Health. A certificate or instrument, signed by proper authorities, delivered to the masters of ships at the time of their clearing out from all ports or places suspected of being infested by particular disorders, certifying the state of health at the time that such ships sailed. Bills of health are of three kinds—*clean*, *foul*, and *suspected*, which are self-explanatory terms.

Bill of Lading. A document, subscribed by the master of a ship, acknowledging the receipt of goods intrusted to him for transportation, and binding himself (under certain exceptions) to deliver them to the person to whom they are addressed, in good condition, for a certain remuneration or freightage. Of bills of lading there are usually triplicate copies; one for the party transmitting the goods, another for the person to whom the goods are addressed, and the third for the master.

Bill of Quantities. In estimating the probable cost of a building, the abstract, or the résumé of the detailed calculations, is called the bill of quantities; it contains the amount of the separate items of the various trades, and is carried to the abstract, or the sums of the same.

Bill of Rights. In Law, the declaration delivered by the two houses of parliament to the prince of Orange, February 13, 1688, at the period of his election to the British throne; in which, after a full specification of various acts of James II. which were alleged to be illegal, the rights and privileges of the people were asserted.

Bill of Sale. In Law, a contract under seal, by which a man passes his interest in goods and chattels to another, and which does not require either valuable consideration or actual transfer of the goods to support it, as between the vendor and vendee; although as between the vendee and the vendor's creditors the absence of such consideration and transfer would in general be held indicative of fraud, and invalidate the contract.

Bill-board. In Navigation, an iron-shod stool on which the flukes of the anchor are stowed.

Billet (Fr. billot). In Heraldry, a bearing of which the origin is very uncertain; represented of an oblong square form, sometimes showing the thickness, and always with a flat surface. Billetty, or semée of billets, signifies that the escutcheon or charge is strewed over with these bearings, without regard to particular number or station.

Billet and Zigzag. A moulding frequently introduced in Mediæval Architecture, consisting of a torus ornamented by alternate chequers, like a staff cut into short lengths and disposed horizontally or around a moulding, and of another moulding composed of a series of small projections, arranged round a curve in alternate directions but in a consecutive manner.

Billiards (Fr. billard). A game played on a rectangular table, bordered by elastic cushions, generally about twelve feet long by six feet wide, with ivory balls, which being struck with the end of a stick, called a cue (French, *queue*), are caused to strike each other and are driven into holes at the angles and sides of the table, according to certain rules. Several different kinds of games are played, but the ordinary English one is as follows. Two players, opposed to each other, have each one white ball (distinguished from each other by a slight mark or spot on one of them); and there is a third ball—a neutral one—coloured red, always on the table. The player whose turn it is to make a stroke endeavours—first, as a condition precedent, causing his ball to touch one of the others—to produce one of four effects: (1) to make his ball *also* touch the third ball, which is called a carambole or cannon, and scores two points in his favour; or (2) to drive the red ball into a pocket, which counts three; or (3) to put his adversary's ball into a pocket, which is called a 'winning hazard,' and counts two; or (4) to put his own ball into a pocket, which is called a losing hazard, and scores two if made from the white, and three from the red ball. The same player continues till he fails to make a score, when the other takes his turn. If a player fails to cause his ball to touch one of the others, it scores one against him; and if he happen to put his ball into a pocket without its first touching one of the other balls, it scores three against him. The game is sometimes twenty-one, sometimes fifty, and sometimes one hundred points. After either of the white balls has been pocketed it must be placed, for its owner to begin again, within a certain division of the table, called 'baulk,' and he is prohibited from aiming at any ball that may happen to lie in that space. After the red ball has been put into a pocket, it is replaced upon a certain spot marked on the table for that purpose. On the Continent losing hazards generally score *against* the player; and sometimes all hazards are abolished, the game being played for caramboles only.

Another game of billiards, called *Pool*, is played by several players, each of whom deposits a certain stake towards the pool and has a separate ball, the several balls being of dif-

ferent colours to distinguish them from each other. The players make strokes in turn, the object being to drive any of the opponents' balls into the pockets, and so clear them off the board; the last remaining wins the pool.

Billiards is a fine game, and very popular; to play it well requires highly cultivated qualities of eye and hand, and much judgment and practice. The points in which excellence of play is shown are: accuracy of aim; accurate graduation of the strength of the blow; just estimation of the angles of incidence and reflection, from both the balls and the cushions; modification of the effects by different modes of hitting the ball, and by giving it different directions and velocities of rotation; attention to the state of the score; judgment as to the proper object to try for; and prescience as to how the balls will remain after the stroke is completed. The mathematical rule 'that the angles of incidence and reflection are equal,' although useful in billiards as a general guide, does not fully apply, as the angle at which a ball will fly off from another ball, or from the elastic cushion, is considerably modified by the amount and direction of rotation possessed by the striking ball. A ball may strike the cushion perpendicularly, and yet if it has a horizontal rotation (caused by striking it on one side instead of in the centre), it will rebound at a very oblique angle. Great use is made by skilful players of this element of the game.

Billion (Fr.). In Numeration, denotes a million of millions, and is expressed by 1000000000000. The French use the same word to denote a thousand millions. The term is probably a contraction of *bis* and *million*; whence the English signification, a million of millions, appears more according to analogy.

Bills of Mortality. Are accounts of the number of births and burials within a certain district in every week, month, quarter, or year. These were first compiled in London after the great plague of 1593; and ten years afterwards began to be returned weekly. Several of the parishes now included within the metropolis (as Marylebone and Pancras) are not within the bills of mortality. [MORTALITY.]

Bilobate (Lat. bis, and Gr. λοβός, *a lobe*). When a part is divided into two lobes, or obtuse processes.

Bilocular (Lat. bis, and loculus, *a cell*). Having two cells.

Bimaculate (Lat. bis, and macula, *a spot*). When an animal or part is marked with two spots.

Bimana (Lat. bis, and manus, *a hand*). The term applied by Cuvier to the highest order of Mammalia, of which man is the type and sole genus.

Bimedial (Lat. bis, and medius, *middle*). In Geometry, when two lines commensurable only in power (for example, the diagonal and side of a square) are joined together, the sum is irrational with respect to either of the two lines, and is called a *bimedial*.

Binary Arithmetic. A species of arithmetic, proposed by Leibnitz, and founded on the shortest and simplest progression; namely, that which terminates with the second cipher. In the binary notation, therefore, only two characters are required, 1 and 0, the zero having the power of multiplying the number it follows by two, as in the common notation it multiplies by ten. The number *one* is represented by 1; *two*, by 10; *three*, by 11; *four*, by 100; *five*, by 101; *six*, by 110; *seven*, by 111; *eight*, by 1000; *nine*, by 1001; *ten*, by 1010, &c. This method of notation, though it may be applied with advantage in the investigation of some properties of numbers, would be inconvenient for common purposes, on account of the great number of characters required, even when the numbers to be expressed are small. We will give an example from the *Encyclopédie Méthodique* of the method of expressing a number by the binary scale, and of finding the value of a number so expressed.

It is convenient to begin with forming a table of the powers of 2, namely, $2^0, 2^1, 2^2, 2^3$, &c. They are 1, 2, 4, 8, &c. Suppose, now, it were required to express the number 230 by the binary scale. Seek in the table the greatest power of 2 contained in 230; it is found to be 128, which is the 8th number in the table; hence the expression will contain 8 ciphers, and the first on the left hand is 1. Subtract 128 from 230, the remainder is 102; the highest power of 2 contained in this is 64, which is the 7th number in the table. The second cipher will therefore be also 1. Subtract 64 from 102, and the remainder is 38. But the 6th number in the table is 32, which is less than 38; therefore the third cipher in the expression is still 1. Subtract 32 from 38, the remainder is 6; but the 5th number in the table is 16, which is greater than 6; therefore the 4th cipher of the expression is 0. The 4th number in the table is 8, which is also greater than 6; therefore the 5th cipher must also be 0. The 3rd number in the table is 4, which is less than 6; therefore the 6th cipher will be 1. Subtracting 4 from 6, the remainder is 2: but the second number in the table is 2, therefore the 7th cipher is 1. The last difference is zero; therefore the last cipher in the expression is 0. Collecting all these results, we find the number 230 is expressed in the binary scale by 11100110.

Next, suppose it were required to determine the value of the expression 110101 in the binary scale. As there are here 6 ciphers, we look for the 6th number in the above table, and find 32, which is the value of the 1st cipher. The following cipher represents the 5th number, and is consequently equal to 16. The 3rd cipher is 0, and its value nothing. The 4th cipher corresponds to the 3rd number in the table, and represents 4. The 5th cipher is 0, and its value nothing. The last cipher corresponds to the first number of the table, which is 1. The whole expression, therefore, 110101, is equivalent to $32+16+4+1=53$. It has been imagined, though on very slight

grounds, that traces of the binary notation are discernible among the early monuments of China.

For information on the subject of arithmetical scales, see Leslie, *Philosophy of Arithmetic.*

Binary Measure. In Music, that in which there are two even beats in a bar, usually called common time.

Binary Theory. A view which supposes all definite chemical salts to be combinations of two bodies. The two bodies may be simple radicals (elements) or compound radicals, or one of each class. Sulphide of potassium is a binary compound, containing the elements sulphur and potassium. Cyanide of ethyl is a binary compound containing the radicals cyanogen and ethyl. Sulphide of ethyl is a binary body containing an element and a compound radical. With regard to the constitution of these bodies all chemists are agreed. Their views respecting the constitution of the oxysalts are less unanimous. Sulphate of potash, for instance, has usually been considered to be composed of the binary body potash united with the binary compound sulphuric acid, and therefore to belong to another class of substances—ternary. The binary theorists, however, would consider sulphate of potash to be a binary compound also, containing the simple radical potassium and the compound radical sulphion; i. e. anhydrous sulphuric acid plus one atom of oxygen—

$$K, SO_4 \text{ not } KO, SO_3;$$

and so in regard to other oxysalts. Both hypotheses can be supported by numerous facts and arguments.

Binate (Lat. bis, and natus, *born*). Growing in pairs; when two bodies of the same nature spring from the same point, as often happens in the segments of leaves.

Bind. A technical name in some parts of the country for the shales alternating with the coal in the coal measures. Such rocks are generally more or less calcareous, and alternate with sandstones and bands of ironstone nodules; they not unfrequently contain concretions of carbonate of lime and iron. [SHALE.]

BIND. In Music, a ligature or tie for the purpose of grouping notes together.

Binder. The name generally given to a beam intended to tie, or bind, together any building. It is applied commonly to the principal piece of timber in a double floor, in which it performs the part of a girder to carry the intermediate parts of the bearing of the ceiling and of the floor joists.

Binding Coal. [CLOSE-BURNING COAL and CAKING COAL.]

Binervate (Lat. bis, and nervus, *a nerve*). In Entomology, when the wing of an insect is supported by only two nerves.

Binnacle or **Bittacle.** In Navigation, the case or stand in which the steering compass is placed. It is fixed near the tiller or wheel. At night the compass is illuminated by a lamp placed over it.

Like many other sea terms, the word is of very doubtful origin. The form *binnacle* seems to indicate that the word is a corruption from Binocle [which see]; while the form *bittacle* has led Mr. Wedgwood to connect it with the French *habitacle*, from the Low Latin *habitaculum*, as meaning a place for the steersman and the pilot. [BARNACLES.]

Binnite. A mineral found in the Dolomite of the Binnen Valley, in the Valais. It occurs in right rhombic prisms which are longitudinally striated and of a colour varying from steel-grey to black.

Binocle or **Binocular Telescope** (Lat. binus, *double*, and oculus, *the eye*). A telescope to which both eyes may be applied at once, and in which, consequently, an object may be observed with both eyes at the same time.

Binocular Perspective. [PERSPECTIVE.]

Binomial (Lat. bis, and Gr. *νόμος*, *law*). In Algebra, signifies a quantity composed of two terms, connected together by the signs + or −; thus, $a+b$ and $c-b$ are binomial quantities.

Binomial Equation. An equation which consists of two terms, and is, therefore, reducible to the form $x^n = A$ or $x^n - A = 0$. It has, of course, n roots, all of which are unequal. If a be any one of them, then, putting $x = ay$, the equation is reduced to $y^n - 1 = 0$; so that the n roots in question may be found by multiplying any one of them by the several *n^{th} roots of unity*. [ROOTS OF UNITY.]

Binomial Theorem. A formula, discovered by Newton, for expressing any power of a binomial quantity. It is usually written thus—

$$(1+x)^n = 1 + nx + \frac{n(n-1)}{1.2}x^2 + \frac{n(n-1)(n-2)}{1.2.3}x^3 + \&c.$$

from which four terms the law of the whole series will be sufficiently apparent. The method of obtaining the formula and of proving its validity for all values of n, will be found in any good algebra. When n is a positive integer the series is finite, and consists of $n+1$ terms; in all other cases it is infinite, but convergent whenever x is numerically less than 1, no matter what n may be. It would be useless to attempt to describe the applications of this formula in mathematics: it is beyond question the most important one of elementary algebra.

Binormal (Lat. bis, and norma, *a rule*). A term employed by Saint-Venant (*Jour. de l'École Polytechnique*, cah. 30) to denote the line through a point of a non-plane curve which is perpendicular to two consecutive elements. It lies of course in the normal plane and is perpendicular to the osculating plane. The locus of binormals to a given curve is a skew surface the generators of which are cut orthogonally by the curve.

Biocellate (Lat. bis, and ocellus, *an eyelet*). In Entomology, when an insect's wing is marked with two eyelike spots.

Biogenesis (Gr. *βίος*, *life*, and *γένεσις*, *birth*). A word used by Zoologists to define

the science which speculates upon the mode by which new species have been introduced on this planet.

Biography (Gr. *βίος*, and *γράφω*, *I write*). The history of the life of an individual. Biography, in the progress of literature, appears to be nearly coeval with history itself. It has been ingeniously described as 'history teaching by example;' and this mode of instruction was perhaps peculiarly appropriate to early and simple times, in which the relative importance of individual men to the society in which they lived was greater than it can ordinarily be in periods of more advanced civilisation. But, although we have notices of many biographical writers among the classical authors of Greece, none of their works have been preserved to us (if we except the short narrative of the exploits of Agesilaus by Xenophon, for his celebrated Memorabilia of Socrates are rather in the form of a collection of sayings and anecdotes than a memoir) of earlier date than the Roman Empire. It is to a comparatively late age that we owe all the more interesting works of this description, some of which are among the most popular relics of the classical ages—the *Lives of Illustrious Men*, by Plutarch and Cornelius Nepos; the *Lives of the Cæsars*, by Suetonius, a work of which the details are strictly biographical; and the *Lives of the Philosophers*, by Diogenes Laertius. Biography may be said in strictness to differ from history not merely in the extent of the subject, but also, and perhaps more characteristically, in the mode in which that subject is treated. Thus, in classical literature, the works of Quintus Curtius and Arrian, although devoted exclusively to the actions of a single individual (Alexander), are not usually termed biographies; not only because the individual in question was the leader and foremost character in a course of great public events, but also because those public events form the subject matter of their works, and not the more peculiar details of the personal life of their heroes. They are therefore more accurately denominated histories than biographies. On the other hand, the *Lives of the Twelve Cæsars* by Suetonius form, as has been said, a series of biographies, although the persons who furnish the subject were, like Alexander, arbiters of the destinies of a great part of mankind; because the details which they contain are chiefly of a private and personal nature. It is the object of history, among its other lessons, to make us acquainted with the influence which the actions, the characters, and the thoughts of individual men have produced on the course of events affecting society in general: conversely, it appears to be the province of the biographer to detail the effects which have been produced by external occurrences and circumstances on the character and conduct of individuals.

The best biographical dictionaries, though very imperfect, are the two French publications, *Biographie Universelle*, commenced in 1811 and continued by supplements; and the *Nouvelle Biographie Universelle*, commenced 1853 and still in progress. English literature has nothing whatever to show in this branch, except the old *Biographia Britannica* (of Kippis) and Chalmers' *Dictionary*, commenced 1812, almost confined to literary notices of England, and extremely defective as to these.

Biotine. The name given by Monticelli to the Anorthite which occurs among the old lavas at Vesuvius. It is transparent, of a whitish or yellowish colour, and is distinguished from the other minerals with which it is associated by superior brilliancy. Named after the French chemist Biot.

Biotite. Uniaxial or Magnesian Mica. It occurs in six-sided tabular prisms, which have a perfect basal cleavage and are sometimes colourless, but generally dark green or brown, or nearly black. It has a vitreous lustre, varies from transparent to opaque, is sectile, and flexible, and elastic when reduced to thin laminæ. It occurs in Skye, and at Inverness in Scotland; also at Vesuvius. Named after Professor Biot, who first pointed out the optical differences between the different kinds of Mica. [MEROXENE.]

Bipectinate (Lat. bis, and pecten, *a comb*). When a part has two margins toothed like a comb.

Bipeltate (Lat. bis, and pelta, *a buckler*). When an animal or part has a defence like a double shield.

Bipupillate (Lat. bis, and pupilla, *the pupil of the eye*). In Entomology, when an eye-like spot on the wing of a butterfly has two dots or pupils within it of a different colour.

Biquadratic. In Algebra, denotes the power immediately succeeding the cube; that is, the square of the square, or fourth power.

Biquadratic Equation. An equation of the fourth degree; that is to say, an equation wherein the fourth, but no higher, power of the unknown quantity appears. Its general form is—

$$x^4 + px^3 + qx^2 + rx + s = 0;$$

and its solution, as was first shown by Ferrari, may be made to depend upon that of the cubic equation

$$y^3 - qy^2 + (pr - 4s)\, y - s\,(p^2 - 4q) - r^2 = 0;$$

which is termed its *resolvent*. In fact, y being any root of this equation, those of the original will be the roots of the following two quadratics

$$x^2 + \left(\frac{p}{2} \pm \sqrt{\frac{p^2}{4} - q + y}\right)x + \left[\frac{y}{2} \pm \frac{py - r^2}{4\sqrt{\frac{p^2}{4} - q + y}}\right] = 0,$$

where first the upper and then the lower signs are to be taken together. To verify this statement, it is merely necessary to multiply together the two last quadratic expressions; it will be found that their product, in virtue of the resolvent, reduces itself to the original quartic. Other solutions have been given by Descartes,

Waring, Simpson, Euler, Lagrange, and others, for a complete account of which, as well as for a full discussion of the problem, see Todhunter, *Theory of Equations*; Serret, *Algèbre Supérieure*, &c.

Biquaternion. [QUATERNION.]

Biradiate (Lat. bis, and radius, *a ray*). When a part has two rays.

Birch (A.-Sax. birc). A hardy tree inhabiting the north of Europe, Asia, and America. The Common Birch (*Betula alba*) is valuable for its capability of resisting extremes of both heat and cold; its timber is chiefly employed for fire-wood; and its bark is extremely durable. The empyreumatic oil of the birch is used in preparing Russian leather, to which it gives its peculiar odour. The American Birch (*B. lenta*) produces a hard heavy timber, much used by cabinet-makers. The bark of the Paper Birch (*B. papyracea*) is employed by the North American Indians for a variety of useful purposes: among others to form canoes. The bark of the Black Birch (*B. nigra*) yields a resinous substance known as Birch Camphor.

Bird of Paradise. A name originally applied to the species *Paradisea apoda*, Linn.; of which the skins, deprived of the wings, the feet, and the tail, have long formed a high-priced article of export from the eastern parts of the world. The value of these mutilated specimens of natural history arises chiefly from the extraordinary developement and light and beautiful structure of the plumes which grow from the scapular and lateral regions of the body; and these plumes, combined with the velvety texture and brilliant metallic reflections of the ordinary feathers, especially those covering the head, render skins of the *Paradisea* ornaments highly esteemed by the fair inhabitants of the most civilised countries. The remarkable plumage and the constant absence of the ordinary organs of locomotion in the imported specimens, easily gave rise to strange speculations as to the nature of this rare bird of the East; and the older naturalists delighted to describe it as destitute of feet, dwelling constantly in the air, wafted about in the bright beams of the sun independently of the ordinary mechanism of wings, and nourished with dew and the nectar and even odour of flowers. To beings thus imagined to be raised above the dull earth, and to enjoy ethereal food and a perpetual habitation in the air, no name could be more appropriate than Birds of Paradise or Heaven. The march of enquiry has, however, dispelled the fancied attributes and false charms of these lovely beings, and has restored to them their wings and feet. The latter, indeed, are remarkable for their robustness: they have three toes in front and one behind, as in other *Passeres* of Cuvier, with the middle toe shorter than the tarsus, the outer toe united to it at its base, and the inner one joined to it for half the length of the first phalanx. The form of the beak corresponds with that which characterises the tribe *Conirostres* of Cuvier; and their true food, which consists not only of the pulpy and farinaceous parts of fruit, but also of worms, insects, the eggs and young of smaller birds, and even carrion, causes them to be ranked with the family of *Omnivores*, Cuv. In fact, they closely resemble in their habits our magpies and jays. The principal species of the genus *Paradisea* are the Great or Common Bird of Paradise (*Par. apoda* of Linnæus); the Royal Bird of Paradise (*Par. regia*); the Red Bird of Paradise (*Par. rubra*); the Magnificent Bird of Paradise (*Par. magnifica*); the Six-threaded Bird of Paradise (*Par. sexsetacea*), which is characterised by three long and thread-like feathers, which grow from each side of the body; the Superb Bird of Paradise (*Par. superba*), which is smaller than the preceding, but perhaps the most beautiful of the genus; the Small Bird of Paradise (*Par. minor*), which measures about nine inches from the point of the bill to the end of the tail; and, lastly, the White Bird of Paradise (*Par. alba*).

Bird Pepper. A small shrubby *Capsicum* (*C. baccatum*), which is one of the species that afford Cayenne pepper.

Bird's Mouth. In Architecture, an interior angle, or notch, cut across the grain at the extremity of a piece of timber for its reception on the edge of another piece; as a rafter, for instance, upon a pole plate. *Bird's mouth* signifies also the internal angle of a polygon, its external angle being called a *bull's nose*.

Bird's-eye View. In the Fine Arts, a term used to denote a view arranged according to the laws of perspective, in which the point of sight, or the situation of the eye, is placed at a considerable height above the object viewed and delineated. In architectural representations it is used chiefly for the purpose of representing the disposition of the different courts, or quadrangles, or roofs of a building. It is a useful method of representing battles, as also of conveying a general notion of a small district of a country. [PERSPECTIVE.]

Birds. In Heraldry, are said to be rising, displayed, close, volant, &c. according to the different postures in which they are represented. Birds of prey, and cocks, when beaked and legged of a different tincture from the body, are said to be *armed* of that tincture.

BIRDS. In Zoology. [AVES.]

Birdlime. A glutinous substance extracted by boiling the bark of the holly tree; a similar substance may be obtained from mistletoe, from the young shoots of elder, and some other plants.

Birth, Evidence of. By the French *Code Civil* it is required that a declaration shall be made of every birth to the proper officer, within three days, with production of the child. The 'act of birth,' setting forth the time and place of the event, sex, and name of the child, and description of the father, is then immediately drawn up in the presence of two witnesses. It is entered on the register, and a copy kept by the parent. (*Code Civil*, art. 55.) In England by the 70th canon, and statutes of 6 & 7 Wm. III. and 4 Geo. IV. c. 76, the minister of every parish is required to keep a

register of births. But now, by the Act for registering births, deaths, and marriages, 6 & 7 Wm. IV. c. 86, it is enacted that the parent, or occupier of a house in which a child is born, *may*, within 42 days after the birth, give notice to the district registrar; and *shall* give such information on being requested by the district registrar within the same time. After 42 days, the birth may be registered only in presence of the superintendent registrar, and on a peculiar declaration. After six months, registration of a birth cannot take place. Certified registers of births, as well as deaths, are to be forwarded after a certain time to the superintendent registrar, and copies of such registers to the general register office. (Secs. 19, 21, 22, 23, 33, 34.)

Birth, or Berth, of a Ship. The ground or space in which a ship is anchored, and which is said to be a *good birth*, or a *bad birth*; also, an apartment, as the midshipman's birth; also the space allotted to a seaman to sleep or hang his hammock in.

Bis (Lat. *twice*). In Music, a word placed over passages which have dots postfixed to one bar, and prefixed to a subsequent bar, signifying that the passage between the dots is to be played twice over.

Biscuit (Fr. *twice cooked*, like the German zwieback, *twice baked*). In Sculpture, a species of porcelain, of which groups and figures in miniature are formed, which are twice passed through the furnace or oven. It is executed without glaze upon it. In Pottery, this term is applied to earthenware and porcelain, after it has been hardened in the fire, and before it receives the glaze: in this state it is permeable to water.

Bisetous (Lat. bis, and seta, *a bristle*). In Zoology, when an animal or part is furnished with two bristle-like appendages.

Bisexual (of two sexes). Is a term applied to flowers which contain both stamens and pistil within the same envelope: it is the same as the word hermaphrodite in botany.

Bishop (Gr. ἐπίσκοπος, Lat. episcopus, *an overseer*). In all denominations of Christians which admit the episcopal form of government, the bishop is the superior of the three orders, standing in rank and office distinct from the presbyter or priest. [EPISCOPACY.] This distinct office consists in the power of ordination, confirmation, and consecration, none of which ceremonies may be performed by an inferior clergyman. The clergy of a diocese are subjected also to the ecclesiastical authority of their bishop, who alone institutes to benefices, licenses curates, and has considerable discretionary power in requiring the residence of his clergy on their cures, and in superintending the discharge of their duties in them.

The mode of appointment to bishoprics varies in different establishments. In early times the bishop was generally elected by his clergy and laity. After the establishment of Christianity, the Eastern emperors assumed the right of nominating to some of the principal sees, and exercised great influence over the elections generally. In the West of Europe the kings of the barbarians, after the conversion of their subjects, arrogated to themselves similar authority, which was jealously counteracted by the see of Rome. In the middle ages the pope assumed in most cases the absolute nomination, which claim has been given up in later times in many Catholic countries, where the king or clergy recommend and the pope only ratifies the appointment. In England the appointment is virtually in the hands of the sovereign, who upon the demise of the bishop receives from the dean and chapter intimation of the event, with a request for permission to supply the vacancy. The king accords his permission to that effect, and at the same time recommends a person to their choice—a recommendation which is equivalent to a command, as it cannot be waived without incurring the severe penalties of a præmunire.

Bismuth. A brittle yellowish-white metal, of a crystalline texture. Its specific gravity is 9·8; it fuses at 507°, and at a red heat it sublimes in close vessels. It conducts heat less perfectly than most of the other metals. When strongly heated it burns with a bluish-white flame, and is rapidly oxidised. Its equivalent upon the hydrogen scale is 213; and it forms only one salifiable oxide, which is a ter-oxide, $=BiO_3$. When nitrate of bismuth is dropped into water a white powder is thrown down, formerly called *magistery of bismuth* or *pearl white*: it is a subnitrate. A brown *peroxide of bismuth*, $=BiO_5$, is obtained by fusing the teroxide with caustic potash. Some of the alloys of bismuth are remarkable for their fusibility: a compound of 8 parts of bismuth, 5 of lead, and 3 of tin, melts in boiling water, and is commonly called *fusible metal*. The ores of bismuth are not common; but it occurs *native*, and combined with oxygen, sulphur, and arsenic. The Germans call it *wismuth*.

Bismuth Lead-ore. [NEEDLE ORE.]

Bismuth Nickel. [GRÜNAUITE; SAYNITE.]

Bismuth Ochre. A dull earthy mineral of a yellowish or ash-grey colour, sometimes verging on apple-green, which is found in Cornwall at the Royal iron mine near Lostwithiel, and in small quantities in the parish of St. Roach at Cost-all-lost Mine. It consists according to Lampadius of oxide of bismuth 86·4, oxide of iron 5·1, carbonic acid 4·1, water 3·4.

Bismuthine. Tersulphide of bismuth, composed of 81·6 per cent. of bismuth, and 18·4 sulphur. It occurs in lodes and beds in the older rocks, together with ores of arsenic, copper, iron, lead, &c.; either crystallised in acicular (often minute) prisms, or massive with a foliated structure like that of Galena, or fibrous like Antimony. The colour and streak are tin-white or lead-grey, sometimes yellowish-white, with an iridescent tarnish; lustre metallic; opaque, soft and brittle; fuses in the flame of a candle.

Bismuthine is found in Cornwall and in Cumberland. The principal foreign localities are Siberia, Norway, Sweden, Saxony, Bohemia, &c.

Bismutite. Native carbonate of bismuth, composed of 90·28 per cent. of oxide of bismuth, 6·29 carbonic acid, and 3·43 water. It occurs in pseudomorphous acicular crystals after Bismuthine, in Saxony at Johanngeorgenstadt, Ullersreuth, and Aue; also after Native Bismuth at Schneeberg. The Bismuth-glance of the gold-mines at Chesterfield, South Carolina, consists of hydrated carbonate of bismuth, with small quantities of earthy admixtures.

Bison (Gr.). A genus of Bovidæ, found in both the Old and New Worlds. The aurochs (*B. Bonassus*) with 14 ribs, and the American bison (*B. Americanus*), form the typical examples of the genus. In India and the Sunda Isles the Gayal (*B. frontalis*), the Gour (*B. Gaurus*), and the Banting (*B. Banting*) are found, and have been erroneously considered to be the source of our domestic oxen, from which they are clearly distinguished by the number of ribs (13 in *Bos*). The Yak (*B. poëphagus*) is found in Thibet, and is the species from which the so-called horsetails denoting rank in the East, are derived. Three species of Bison are known to palæontologists, one of which (*B. priscus*) coexisted with the gigantic true oxen and buffaloes of the Pliocene period.

Bispinosus (Lat. bis, and spina, *a spine*). When an animal or part is armed with two spines.

Bissextile (Lat. bis, *twice*, and sextilis, *sixth*). The name given to the year which contains 366 days. The calendar used in all European countries is founded on that of the Romans, as reformed by Julius Cæsar. In the calendar of Cæsar the length of the year was fixed at 365¼ days; and in order that the year should always begin with the beginning of a day, it was directed that every fourth year should contain 366 days, the other years having each 365. The additional day, which thus occurred every fourth year, was given to February, the shortest month, and was inserted in the calendar between the 24th and 25th days. In the peculiar method of reckoning the days of the month adopted by the Romans, namely, of reckoning backwards from the 1st of the succeeding month, it would have been very inconvenient to interrupt the order of numeration; accordingly the 24th, which was called *sexto Calendas Martii*, was reckoned twice, and the supernumerary or repeated day called *bis sexto Calendas*. Hence the term *bissextile*. In English, *leap year* has the same signification.

In the Julian calendar every year was bissextile; but this supposes the year to be 365¼ days, which errs in excess by 11 minutes 10·35 seconds. Accordingly, in the course of a few centuries, the error will amount to days, and cause the commencement of the year to change its place with respect to the seasons. When the Julian calendar was introduced, the equinox fell on the 25th of March; in 1582, when the calendar was reformed by Pope Gregory XIII., it had fallen back to the 11th; and as it was then supposed that the error of the Julian calendar amounted to three days in 400 years, it was ordered that the intercalary day should be omitted in all the years which terminate centuries, excepting those which are multiples of 400. The Gregorian rule of intercalation is therefore as follows: Every year of which the number is divisible by 4 is a leap year: excepting the centesimal years, which are only leap years when divisible by 4 after suppressing the two zeros. Thus 1600 was a leap year; but 1700, 1800, and 1900, which would be bissextile in the Julian calendar, are common years in the Gregorian.

This regulation, though it would for a long time preserve the commencement of the year at the same place in the seasons, is not yet quite correct. It supposes the length of the year to be 365 days 5 h. 48 m. 12 seconds, which is too great by 22·38 seconds; an error which amounts to a day in 3,866 years. As this number 3,866 approaches to 4,000, it was proposed by Delambre to correct the Gregorian rule by making the year 4000 and all its multiples common years. Should our present calendar continue to be in use 2,000 years hence, posterity may then begin to consider whether they will adopt this suggestion. [CALENDAR.]

Bistort (Lat. bis, and tortus, *twisted*). The root of the *Polygonum Bistorta*, an indigenous plant; it is used in medicine as a powerful astringent.

Bistre. In Painting, a dark brown colour, made from the soot of dry wood, for which purpose that of dry beech is preferable.

Bisulcate (Lat. bis, *twice*, and sulcus, *a furrow*). In Mammalogy, a term signifying a foot resting upon two hoofed digits.

Bit (A.-Sax. bitol). That part of the bridle which goes into the mouth of a horse.

BIT. A general name for the metal part of several tools used for boring, and made so as to fit at the upper end in the handle of a socket; they are applied for boring large holes in hard wood, and in all cases where accuracy is required. The bit of a key is the part fitted to the shank in which the wards are cut; this is called a blank until the wards are so cut. The term is also used for the hammer used by masons for rough picking, or dressing granite.

Bittacle. [BINNACLE; BINOCLE.]

Bitter Apple. The fruit of the *Citrullus* or *Cucumis Colocynthis*.

Bitter Principle. This term has been applied to certain bitter products of the action of nitric acid upon animal and vegetable matters. [CARBAZOTIC ACID.]

Bitter Salt. Sulphate of Magnesia, or Epsom Salt.

Bitter Spar. A Mineralogical term, generally applied to certain crystallised or large-grained and easily cleavable varieties of *Dolomite*, or double carbonates of lime and magnesia. It usually occurs in obtuse rhombohedrons,

nearly allied to carbonate of lime, and consists of about 55 per cent. of carbonate of lime, and 45 of carbonate of magnesia, the latter being sometimes replaced by small quantities of iron and manganese. It is a common mineral in many English localities, but the finest and most transparent crystals are found at Traversella in Piedmont, at St. Gothard, and near Gap in France. [BROWN SPAR; PEARL SPAR; TALC SPAR; DOLOMITE.]

Bittern. [ARDEA.]

BITTERN. The residue of sea water after the common salt has been separated by evaporation. It contains *muriate of magnesia*, which gives it a bitter taste.

Bitts. In Navigation, strong pieces of wood firmly fixed on the deck round each mast for the purpose of leading and securing ropes. Cable bitts are stronger and heavier, being encased in iron, and used to check or ease the cable when going out.

Bitumen (Lat.; probably from Gr. *πιτύς, the pitch tree,* because it resembles pitch). A name under which are included several distinct varieties of inflammable mineral substances, which, like pitch, burn with flame in the open air. [ASPHALT; ELASTIC BITUMEN; MALTHA or MINERAL TAR; PETROLEUM.]

Bituminous Coal. The term commonly applied to coals which burn with a smoky flame, and occupy a place between Lignite on the one hand, and Anthracite on the other.

Bituminous Shale. In many coal fields in various parts of the world there are numerous bands of tough clayey matter of a grey, brown or black colour, sometimes passing into coal, and resembling bad coal in appearance. They have more or less of a slaty fracture, are often repeated, like other beds of clay, in a vast thickness of strata, and occupy a definite position with regard to coal. They are found generally, but not always, near true coal of all ages. The *posidonia schists* of the lias, and the *paper coal*, so called, of the tertiary period, near Bonn, are varieties.

Although some of these shales yield much gas on exposure to destructive distillation [GAS], they are even more valuable as affording oils and paraffine, when distilled at a dull red heat.

The percentage of oil obtained from bituminous shales varies exceedingly, but less than five per cent. can hardly be remunerative. Some of these, which afford as much as thirty per cent., are extremely valuable, such as the so-called *Boghead coal*, or *Torbane mineral* of Scotland. [PARAFFINE.] Shales approach coal in their appearance, and are used for burning.

Bituminous Wood. [LIGNITE.]

Biuret. One of the products of the action of heat upon urea. It occurs in granular crystals, and is intimately related to bicyanate of ammonia.

Bivalves (Lat. bis, and valva, *a valve*). A term commonly applied to the Lamellibranchiate Acephalous Molluscs, on account of the structure of their shell, which consists of two parts or valves, joined together by an elastic ligament at the cardo or hinge. The testaceous covering of the Palliobranchiates is also composed of two valves or shelly pieces; but these are never joined by elastic ligament.

Bivouac (Fr., from Ger. beiwache, *by-watch*: Latham). A term in the Military art, employed to denote the system by which soldiers on a march, or in expectation of an engagement, remain all night in the open air, in contradistinction to the systems of encampment and cantonment.

Bixaceæ (from Bixa, *one of the genera*). Another name for the *Flacourtiaceæ*, an order of Hypogynous Exogens, containing the genus *Bixa*, one of whose species, *B. Orellana*, produces the substance called arnotto, used for colouring cheese. The species are all trees or shrubs inhabiting the tropics.

Bixin. The colouring principle of annotto.

Black Amber. The name given to Pitch-coal by the amber diggers of Prussia, who manufacture it into various ornamental articles.

Black Ash. Impure carbonate of soda.

Black Band. A variety of Clay-ironstone or compact carbonate of iron, often containing as much as from 25 to 30 per cent. of carbonaceous matter. It occurs largely in the coal-fields of North Staffordshire and Scotland, and is the ore almost exclusively used in the latter country for the production of iron. Strata of Black Band are also found abundantly in beds between the coal-seams of the Westphalian Coal-measures on the Ruhr, in the Coal-measures on the Worm (district of Aachen), and in those on the Inde.

Black Cap. This term is generally applied to a species of frugivorous warbler (*Curruca Atricapilla* of Brisson); but it is also occasionally given to the great titmouse (*Parus Fringillago*), the marsh titmouse (*Parus palustris*), the black-headed bunting (*Emberiza Schœniclus*), the stonechat (*Rubetra Rubicola*), and even to the black-headed gull.

Black Chalk. A kind of black clay, containing a large quantity of carbon, found in Caernarvonshire and the isle of Isla; also in France, Portugal, Spain and Italy. The finer sorts are made into artists' crayons, and used for drawing on paper.

Black Coal. One of the three species into which Coal was divided by Jameson. It comprises Slate Coal, Cannel Coal, Foliated Coal, &c.

Black Cock. The name of a native species of grouse. [TETRAO.]

Black Copper. An earthy oxide of copper, resulting from the decomposition of other ores. [MELACONITE.]

Black Drop. A preparation of opium, known also under the name of *Lancaster*, or *Quakers' black drops*. It is said to be a solution of opium in verjuice.

Black Flux. A mixture of carbonate of potash and charcoal, obtained by deflagrating *tartar* with half its weight of *nitre*.

Black Garnet. [MELANITE.]

Black Hæmatite. [PSILOMELANE.]

Black Jack. The name usually given by Cornish miners to Blende or sulphide of zinc. In some localities the occurrence of this ore is looked upon by the miners as a favourable indication, and there is a common saying that '*Black Jack rides a good horse;*' in other districts, on the contrary, Black Jack is said to '*cut out the ore.*'

Black Lead. A name commonly, but improperly, applied to Plumbago or Graphite, in consequence of the mark it leaves when drawn across paper, like that produced by lead.

Black Letter. Is the name now applied to the old English or modern Gothic letter, which was introduced into England about the middle of the fourteenth century, and became the character generally used in MS. works before the art of printing was publicly practised in Europe. On the application of that art to the multiplication of books, about the middle of the fifteenth century, the block books, and subsequently those printed with movable types, were in this character, in imitation of writing. The first printed Bible, known as 'the Mentz Bible,' or 'the Mazarine Bible,' without date, a copy of which was found about the middle of the last century in the library of Cardinal Mazarin, in Paris, was an instance of this. Books printed before the year 1500 are generally in this character, and are styled black-letter books. (Hallam, *Literature of Europe*, vol. i. pt. i. chap. iii.)

Black Manganese. [HAUSMANNITE.]

Black Sea. This great inland sea, together with the Sea of Marmora, which connects it with the Mediterranean and the Sea of Azof, from which the Crimean peninsula only partly separates it, has an area of nearly 200,000 square miles, and is in an important geographical sense subordinate to the Mediterranean. It also serves to connect the Mediterranean with the Caspian; for the waters of the Don which enter the Sea of Azof, are only separated by a narrow tract of low land from those of the Volga, which enters the Caspian. A small difference in the level of the steppes of Astrakan would at once carry the waters of the Atlantic into the plains of Siberia.

The waters of the Black Sea are much less salt than those of the adjoining larger sea, owing to the quantity of fresh water constantly pouring into them. Another result of this rush of fresh water is, that a current sets round the western shore into the Mediterranean.

The Black Sea is considered to be deep compared with the adjacent seas. It must, however, be in course of silting up.

The mountains of the Caucasus form part of the north-eastern boundary of the Black Sea, and extend into the south of the Crimea. Sudden and severe storms, probably connected with the surrounding mountain-land, are common in the Black Sea during the winter season.

Black Tin. The name applied by miners to tin ore ready for the smelter.

Black Wadd. An ore of manganese. [WAD.]

Black Wash. A lotion composed of calomel and limewater.

Black-bird. [TURDUS.]

Blakeite. Octahedral crystals of iron-alum (Coquimbite) from Coquimbo, named after Mr. J. H. Blake, by whom they have been analysed.

Blanching. In Gardening, is the whitening of the stems, stalks, or leaves of plants by tying them together, or by earthing them up, so as to exclude the light. Its object is generally to diminish the intensity of their native properties, and to render them more crisp and agreeable to the palate.

Blank Cartridge. A cartridge with powder only, used for saluting and drill.

Blank Verse. In some modern languages, the heroic verse of five feet without rhymes. Blank verse is peculiar to the Italian, English, and German languages; having been imported into the two latter from the first. In Italian the line is of eleven syllables; and is used invariably in the drama, and frequently in serious poetry, epic or didactic. In English it was also first adopted by the dramatists, and transferred to epic poetry by Milton. The Miltonic verse is constructed with closer attention to the melody of the cadence and cæsura than the dramatic: it admits also less frequently of the eleventh syllable, which in English poetry must be regarded as a sort of license; while Shakspeare and other dramatists occasionally double the short syllable at the end, and thus extend the number to twelve.

Blaps. A Fabrician genus of Coleopterous insects, now the type of a family (*Blapsidæ*), characterised by the absence of wings; maxillary palpi terminated by a large hatchet-shaped joint; body oblong and oval. All the species are of a dark or black colour, and have the elytra soldered together, and bent down at the sides of the abdomen so as to embrace that part. There are three British species of the genus *Blaps* proper, which are known by the trivial names of 'darkling' or 'church-yard beetles,' and are regarded by the vulgar of this and other countries as insects of evil omen.

Blas. A term applied by Van Helmont to certain supposed emanations of the heavenly bodies.

Blasphemy (Gr. *βλασφημία*). According to its supposed etymology, this word signifies the offence of using injurious language, as calumny, reviling, &c.; and in this sense it is used in the New Testament; the word 'railings,' in 1 Tim. vi. 4, being in the original 'blasphemies.' But in the modern and restricted sense, 'blasphemy' signifies the use of insulting, or derogatory, or unbelieving language, with respect to God and divine things. Under this meaning it has been considered a civil crime in most Christian countries, in imitation of the practice which prevailed among the Jews. (Lev. xxix.) In England, by common law, it was punishable with fine, imprisonment, and other corporal punishment. By 9 Wm. III. c. 35, it was first

made a statutable offence, and extended so as to comprehend even the mere denial of some fundamental doctrines of Christianity; and rendered subject to very severe inflictions. Unitarians were relieved from the penalties of this Act by 3 Geo. III. c. 170. But it is almost obsolete in practice with respect to other offenders.

Blast (A.-Sax. blæst). A term used in Metallurgy to express the current of air forced into furnaces by bellows, or air engines, for the purpose of reducing the ores to a merchantable form. There are two kinds of blast in use in the iron manufacture, the hot and the cold blast. The hot blast is obtained by forcing the air through a series of hot pipes, and its effect is to facilitate the fusion of the metal, at the same time that the quality of the latter is deteriorated; the cold blast requires a greater quantity of fuel to reduce the same quantity of ore, and it yields a firmer and more even quality of metal than the hot blast.

Blast Furnace. A furnace fed with air by one or more pairs of bellows or blowing machines. In large iron furnaces the blast is frequently heated before reaching the fuel. [Hot Blast.]

Blastema (Gr.). In Anatomy, the homogeneous gelatinous and granular basis of the ovum, in which the organic elements characteristic of the different tissues are deposited in the early stages of developement.

Blastema. In Botany, the axis of growth of an embryo: that is to say, the plumule, the radicle, and the part which connects them, the cotyledons being removed.

Blasting. [Mining.]

Blastocarpous (Gr. βλαστός, *a germ*, and καρπός, *fruit*). That kind of fruit which germinates inside the pericarp, as the mangrove.

Blastoderm (Gr. βλαστός, and δέρμα, *skin*). In Anatomy, the germinal skin or membrane, or that granular membrane or stratum which lies immediately beneath the membrana vitelli of the ovum, and which is the seat of developement of all parts of the body of birds.

Blastus (Gr. βλαστός). A name sometimes given to the plumule and radicle of grasses.

Blatta (Lat.). A genus of nocturnal Orthopterous insects, commonly called cockroaches, or black beetles. In modern Entomology, it forms the type of a family, including many genera.

Blazonry. The art of deciphering coats of arms; also, that of expressing or describing a coat of arms in appropriate language. The word is supposed to be derived from the German *blasen*, to blow, and to have originated in the ceremonial of tournaments, from which so many other terms and usages in heraldry are derived; it having been customary on these solemn occasions for the herald to blow a trumpet when he called out the arms of a knight on ushering him into the lists. Blazonry requires a knowledge of, 1. The points of the shield, which are nine in number [Points]; 2. The field, that is, the tincture or tinctures forming the ground of the coat [Tincture]; 3. The charges, or devices borne on the field [Charge]; 4. The ordinaries [Ordinary].

Bleaching (Ger. bleichen). This process consists in a series of operations, by which the natural colours of various substances are discharged, so as to whiten them. It is effected either by the action of various solvents, aided by exposure to light, air, and moisture, upon the bleaching ground; or by the aid of chlorine. Cotton is more easily bleached than linen, in consequence of its being originally whiter, and having a less powerful attraction for the colouring matter. In bleaching these goods upon the old principle, warm water is first liberally applied to remove the weaver's paste or dressing; they are then *bucked*, or boiled in a weak alkaline ley; and after having been well washed, are spread out upon the grass, so as to be freely exposed to the joint agencies of light, air, and moisture; the bucking and exposure are alternately repeated as often as necessary; the goods are then *soured*, that is, immersed in water slightly acidulated by sulphuric acid; lastly, they are very thoroughly washed and dried. By these operations the texture of the goods is to a certain extent impaired, and much time is required to complete the process, which also cannot be carried on in the winter months. But the exposure upon the bleaching ground is now to a great extent discontinued; and the same effect is obtained, after the process of bucking, by the action of weak solutions of *chlorine*, or of *chloride* of lime, which, if skilfully used, can scarcely be said to injure the goods more than the long-continued exposure. The theory of bleaching has not been satisfactorily developed; but, from such experiments as have been made in reference to it, it appears to be a process of oxidisement, and to depend upon some peculiar influence of *nascent* oxygen, or perhaps of ozone, upon the colouring matter.

The colour of manufactured wool depends partly upon its own oil, and partly upon the applications made to it in the loom. These are got rid of in the fulling mill by the joint action of fuller's earth and soap; the cloth is then well washed and dried, and is tolerably white. If the slight yellow tint which it retains is objectionable, it is improved by adding a little stone-blue to the washing water, or by exposure to the fumes of burning sulphur; this latter method, however, gives it a harsh feel, and if afterwards soaped its yellowishness returns.

The colour of raw silk depends upon a natural yellow varnish, which is got rid of by boiling it in white soap and water, and by repeated rinsings. Certain articles of wove cotton, such as stockings, are bleached as usual, and finished by the action of *sulphurous acid*, or the fumes of burning sulphur. Straw is also whitened by a similar operation; and hence bleached straw hats are apt to have a disagreeable sulphurous smell. A good account of bleaching will be found in Parkes' *Chemical Essays*.

Bleaching Powder. Chloride of lime, made by exposing slaked lime to the action of chlorine. [CHLORINE.]

Bleinierite. Antimonate of lead; probably a mechanical mixture of lead and antimony ochres, produced by the decomposition of other ores of antimony. It occurs in Cornwall and in Siberia.

Blende (Ger. blenden, *to dazzle*; from its lustre). Native sulphide of zinc; composed, when pure, of 67 per cent. of zinc and 33 sulphur. It occurs crystallised in octahedrons and other allied forms. The colour passes from transparent yellow to opaque black. The lustre is resinous or glassy. The dark coloured kinds often contain sulphide of iron, and frequently 1 or 2 per cent. of sulphide of cadmium is present, especially in the red varieties, as in that of Marmato, near Popayan. [MARMATITE.] Blende is of common occurrence in lodes and metalliferous deposits, associated with most ores and sometimes constituting the matrix of the lode. It is found in large quantities in Cornwall [BLACK JACK], Cumberland, Derbyshire, and the Isle of Man; also in Spain, the Harz, Hungary, Transylvania, Saxony, Bohemia, Sweden, and in many parts of North America.

Blende, though a useful ore, is more difficult of reduction than Calamine: much of the zinc obtained from it is used for making brass.

Blennius (Gr. βλέννα, *mucus*). In Ichthyology, a genus of Acanthopterygian fishes, of the family of Gudgeons (*Gobioidæ*), remarkable for the quantity of mucus secreted from the skin, and for the viviparous generation of some of the species, of which the *Blennius Pholis*, a species common along the shores of Britain, is an example.

Blennorrhœa (Gr. βλέννα, *mucus*, and ῥέω, *I flow*). An inordinate discharge or secretion of mucus.

Blepharitis (Gr. βλέφαρον, *the eyelid*). Inflammation of the eyelids.

Bleu de Paris. A fine blue dye obtained by the action of bichloride of tin on aniline.

Blighia (named after Captain Bligh, of H.M.S. 'Bounty,' who in 1787 conveyed the bread-fruit and other trees to the West Indies from Tahiti). A genus of *Sapindaceæ*, the only species of which, *B. sapida*, is the Akee, an eatable fruit of the West Indies and South America. The edible portion is the aril, a white spongy substance in which the seeds are partially embedded; and this, in tropical countries, is found to possess grateful subacid qualities. The Akee forms a small tree with pinnated leaves.

Blight (Old High Ger. Blich-fiur, *blight-fire*: Wedgwood, Latham). A term in common use for supposed atmospherical injuries received by plants. Before effects were traced to their causes with the same care that they are at present, the sudden discolouration of the leaves of plants, their death, or their being covered with minute insects or small excrescences, was called by the general name of blight; and this blight was attributed to some mysterious influence in the air, to the east wind, or to thunder, because these states of the atmosphere commonly accompanied these phenomena. It is now found that what is called blight is in some cases the effect of insects, to the progress of which the dry state of the atmosphere produced by east winds is peculiarly favourable; while in other cases it is caused by parasitical fungi. The appearance of these fungi on corn crops is frequently designated by farmers as the fire blast: while on peach and other trees in gardens it is called mildew.

The sudden death of plants without apparent cause, and also the withering and drying up of part of their leaves and branches, to which appearance the term blight should perhaps be restricted, are produced by the transpiration of water from the leaves taking place with greater rapidity than it can be supplied by the absorption of the roots, and also by the roots becoming attacked by fungous spawn. In very hot weather in summer, branches of fruit trees trained against walls, or of gooseberry bushes on espaliers, are sometimes withered up in a few minutes from this cause.

What countrymen call the blight on standard apple or other fruit trees in orchards is commonly nothing more than the injuries done to the leaves and buds by the caterpillars of certain moths; that on thorn hedges, by the caterpillar of the saw fly, or of the ermine, or of some other moths; and that on roses, by the aphides or green fly.

Blind Coal. A name given to Anthracite in some parts of Scotland.

Blind Story. A term sometimes used in mediæval architecture to express the triforium of a church, in contradistinction to the clerestory.

Blind Worm. An Ophidian or serpent-like reptile, which is the type of the genus *Cæcilia* [see that word]. The term is also sometimes applied to the slow-worm. [ANGUIS.]

Blindage. In Fortification, a term applied to a shell-proof or splinter-proof roofing, constructed to give cover to magazines, batteries, &c.

Blinkers. Expansions of the sides of the bridle of a horse, to prevent him from seeing on either side, but at the same time not to obstruct his vision in front.

Blister-fly. [CANTHARIS.]

Blistered Copper-ore. The name applied in Cornwall to reniform and botryoidal Copper Pyrites. It is met with at Cook's Kitchen, Huel Basset, and other mines.

Blistered Steel. [STEEL.]

Block (Fr. bloc). In Architecture, this term is applied to large unworked masses of marble or stone; it is also used to denote a modillion in a cornice, or the small projections left on the stones of some buildings, which are supposed to have been indications of the unfinished state of the work, though they are discovered upon some elaborately finished buildings, such as the choragic monument of Thra-

syllus. The introduction of the blocks on the arch stones of the Pont du Gard is a striking illustration of their use.

Block. In Navigation, the case that contains the wheel or *sheave* of the pulley (which last term is not used at sea). Two or more blocks, with the rope, constitute a *tackle*. Blocks are also the pieces of wood and iron on which the ship's keel is supported when she is in dock.

Block Machinery. A system or assemblage of machines for manufacturing the shells and sheaves of blocks required for ship tackle. The term is specially applied to the ingenious machinery invented by the late Sir M. I. Brunel, and set up in the dockyard at Portsmouth between 1802 and 1808, and also at Chatham about 1807, for the supply of the Royal Navy. By these machines every operation connected with the construction of blocks, from the cutting up of the timber to the polishing of the iron pinion on which the sheave turns, is performed with astonishing celerity and precision; and when it is known that a single line-of-battle ship requires about 1,430 blocks for her equipment, the advantage and even the necessity of abridging the labour of construction by appropriate machinery will be understood. Although it would scarcely be possible, without entering into long details and the aid of drawings, to give any idea of the peculiar mechanism employed, the principal operations may be easily indicated. In the first place the rough timber (which is generally elm) is squared by an upright saw; it is then cross cut into pieces of the proper length by a circular saw. These pieces are then brought under the *boring machine*, when one centre bit bores a hole for the centre pin of the sheave, and another bores another hole at right angles to the former at one extremity of the mortise (or two or more such holes are bored when the block is to hold two or more sheaves) to admit the first stroke of the chisel. The next operation is performed by the *mortising machine*, which consists of a set of cutting chisels attached to a movable frame, and making from 100 to 130 perpendicular strokes in a minute, the block being placed on a carriage which at every ascent of the chisels advances forward a little until the proper length has been mortised out. The block is then removed from the mortising machine, and the four corners are taken off by a circular saw, after which it is placed under the *shaping machine*, when, by tens at a time, the proper curvature is given by means of a tool moving in a direction curved towards the line of the axis. Lastly, the *scoring machine* scoops out a groove round the longer diameter of the block to receive the hempen or iron strap which goes round the block, and by which it is suspended when in use, and the *shell* is thus completed. The *sheaves* of the block are made of lignum vitæ, of which a log is first cut into plates of the proper thickness by a circular saw. The plates are then carried to the *crown saw*, which at once bores the centre hole through which the pin is to pass, and gives an exact circular form. They are next brought to the *coaking machine*, for the purpose of having grooves cut in them, on both sides, for the insertion of the *coak* or bush, which is of gun metal and of a peculiar shape (to prevent them from turning in the sheaves), the section being bounded by three semicircles, the diameters of which form the sides of an equilateral triangle. This part of the machinery is exceedingly curious; and so accurately is the operation performed that the coaks are fixed in the sheaves by the tap of a hammer. The two coaks (one on each side of the sheave) are secured by copper rivets passing through them and the sheave—an operation also performed by the machine. The sheave is then completed by turning a groove round its periphery for the rope to run in, and by smoothing its sides, both operations being performed on the same lathe. The iron pin only now remains, and this is also turned and polished by engines for the purpose. The whole of the machinery is put in motion by straps passing over drumheads, and is driven by a single steam engine of 32-horse power. It is found that by means of this machinery ten men can with ease finish in one year from 130,000 to 140,000 blocks of different sizes.

Block Plan. A plan of a ground or dwelling, representing its general arrangement without entering upon any of the details. It is customary to commence a series of plans by such a drawing, which is usually made upon a very small scale.

Block Tin. The tin which is sold in commerce under this name is less pure than the *grain tin*, being made from the common ore of the veins; the best qualities of this metal are the Banca, the Cornish, and the Spanish tin. The term is also applied to articles of inferior value, which are made of iron plate covered with a coating of tin, of variable thickness according to their qualities.

Blockade. In International Law, the right to blockade the ports of an enemy in war, and to exclude neutrals, is limited by the following recognised principles: 1. The blockade must be substantial, by means of a sufficient force to prevent the entry or exit of vessels; otherwise a neutral is not bound to respect it. 2. It is essential that the neutral should have notice of the blockade; otherwise his ship cannot be justly condemned. A counter notice should also be given by the blockading Power when the blockade has ceased. In England, a blockade is properly declared by the king in council.

Blockade. In Military art, signifies effectually confining the garrison within a fortress by a circle of fortified posts. The blockade of Pampeluna is a famous instance of this, and is well described in Sir John Jones's *Journals of Sieges*.

Blockhouse. A wooden building occupying the same position in a fieldwork that a tower does in a permanent fort.

Blocking Course. Masonry or brickwork placed upon the top of a cornice, as the termination of a wall.

Blockship. Is a large vessel of war, employed on coast duty for the protection of a specified district. These ships are rarely fit for operations in the open sea.

Blond Metal. A peculiar kind of Coal-measure Clay-ironstone, which after being smelted is made into a variety of tools. It is found at Wednesbury in Staffordshire.

Blood (A.-Sax. blod). The fluid which circulates in the heart and blood-vessels. When viewed under the microscope it appears to consist of very minute *red globules* floating in a colourless fluid. The average quantity in an adult man is estimated at about 28 lbs. It is of two distinct colours in the arterial and venous systems; florid red approaching to scarlet in the former, and dark crimson in the latter. Its specific gravity is between 1·050 and 1·070. When drawn from its vessels it gelatinises or coagulates in the course of a few minutes at common temperature, and soon separates spontaneously into *serum* and *coagulum*. The serum is a yellowish soapy-feeling fluid, of the specific gravity of about 1·030. It exhibits a slight alkaline reaction upon test papers; when heated it becomes opaque, and at 156° it coagulates. It is also coagulated by alcohol, and by most of the acids; acetic acid and ether do not coagulate it; solutions of corrosive sublimate, of subacetate of lead, and of chloride of platinum occasion precipitates in it, even when considerably diluted with water. These properties of serum are dependent upon the presence of a peculiar proximate animal principle called *albumen*; the same substance, and with very nearly the same properties, constitutes the *white of egg*, the coagulability of which by heat is well known. Besides the above there is another most delicate test of albumen in solution, which consists in adding to the liquid suspected to contain it a little strong *acetic acid*, and afterwards a few drops of a solution of ferrocyanide of potassium. If albumen be present, a white cloud is produced. White of egg is coagulated by ether, while serum is not. According to Marcet 1,000 parts of serum of human blood contain 900 of water, 87 of organic matter and 3 of saline matter.

The coagulum of the blood contains the colouring particles; and when carefully washed, these are carried out of it, and a tenacious whitish matter remains, which has been termed *fibrine*.

The colour of the blood depends upon the presence of small corpuscles, or flattened cells, containing a red colouring principle. In the mammalia, they are not spherical, hence the term globule is inappropriate. They are discs of the shape of a circular double concave lens, being thicker at the circumference than in the centre. Their size bears no proportion to the size of the animal; but the average size varies in different animals. They are larger in man than in most domestic animals; while they are smaller in the sheep and goat than in the pig, hare, and rabbit. In man, they have an average diameter of 1-3200th of an inch: in the goat, of 1-6366th of an inch.

In the blood, there are also colourless nucleated corpuscles of a spherical form, which are rather larger than the red corpuscles, and are similar to the particles found in lymph and chyle.

The red corpuscles in human blood have a sp. gr. of 1·0885; and as the sp. gr. of the serum, in which they are diffused, is 1·030, they have a tendency to sink in it. The corpuscles may thus be collected and examined in serum, which does not dissolve the colouring matter. The *colouring-matter*, to which the term *hæmatosine* has been applied, is an organic principle containing nitrogen and iron in some peculiar state of combination. It has an intense colouring power; and on the breaking of the outer membrane of the corpuscles, the red colour is diffused and communicated to water. The proportion of iron has not been accurately determined; but it is supposed to form from 0·43 to 0·5 per cent. of the dried corpuscles, or 6 per cent. of the pure colouring matter.

An aqueous solution of the colouring-matter, when recent, has an intensely red colour. When heated to about 150°, it is coagulated, the liquid assuming a brown colour. Nitric acid and chlorine destroy the red colour, turning the liquid brown and greenish brown. Weak alkalies in small quantities have no effect upon it. In excess they darken it. Neutral salts produce no change in it. Alcohol and tannic acid render the solution turbid, but do not destroy the red colour.

The following table shows the results of an analysis of human blood by Lecanu (*Annales de Chimie et Physique*, vol. xlviii.); considered *quantitively*, it must only be taken as a mean or approximate result.

Water	780·145
Fibrine	2·100
Colouring matter	133·000
Albumen	65·090
Fat and oily matter	3·740
Extractive matter	1·790
Albumen combined with soda	1·265
Chloride of sodium; " potassium; Carbonates, Phosphates, Sulphates of potassa and soda	8·370
Carbonates of lime; " magnesia; Phosphate of lime; " magnesia; " iron; Peroxide of iron	2·100
Loss	2·400
	1,000·000

Bloodrain. A vegetable growth which sometimes appears in the form of bloodred spots on cooked provisions, and which is re-

ferred to the Algæ, under the name of *Palmella prodigiosa*, but which, according to Mr. Berkeley, seems rather to be one of those conditions of mould which under various colours are common on paste and other culinary articles. The spots consist of myriads of extremely minute granules.

Bloodroot. The root of the *Sanguinaria canadensis*, the juice of which is of a red colour.

Bloodstone. A jaspery variety of Quartz, of a dark green colour, variegated with red spots like drops of blood (whence the name). It is frequently made into seal and ring stones and other small ornamental articles. [HELIOTROPE.]

Certain kinds of hæmatitic iron-ore were called Bloodstone by the ancients, because (as Theophrastus says) they seemed 'as if formed out of concreted blood.' At the present day the term is more especially restricted to the hard and compact hæmatite which is made into burnishers, and which possesses the valuable property of laying on gold and silver leaf without fraying or tearing it; it should be of a deep red colour, free from flaws, close-grained, and susceptible of a fine polish. Galicia in Spain is the country from which the finer descriptions of this variety of hæmatite are almost exclusively obtained.

Bloom. The lump of wrought iron in puddling mills, which leaves the furnace in a rough state, to be subsequently rolled into the bars or other material into which it may be desired to convert the metal; the blooms are already partially converted into wrought iron by passing under the shingling hammer.

Blowers. In Coal Mines. [FIRE DAMP.]

Blowing Machines. Instruments for producing a current or blast of air, chiefly for the purpose of exciting the combustion of fuel, and producing a great heat. The common bellows is an instrument of this kind; but for certain processes in metallurgy, as in smelting and refining ores, the intermittent blast produced by the single bellows is prejudicial, and even in the double form of the machine, as used generally by blacksmiths, the defect is not altogether remedied. Various contrivances have been employed for the purpose of producing a continuous and equable blast, though depending generally on the principle of forcing air into large cylinders or air-chests by means of a force air-pump, and allowing it to escape by eduction pipes under a regulated pressure. For the regulation of the pressure the air may be forced into a vessel inverted in a reservoir of water; but as the air is chilled by its contact with the water, the water regulator is found to be objectionable for large blast furnaces, and a weight is employed. Machines on this principle are in use at every foundry and great engine manufactory; and they have this advantage, that a number of forges may be supplied from the same air-chest. (Ure's *Dictionary of Arts, Manufactures, and Mines*, art. 'Metallurgy.')

Blowpipe. An instrument by which a small jet of air is directed laterally into the flame of a lamp or candle, so as to divert it in a long slender cone upon a piece of charcoal or other substance so placed as to receive it. When a flame is thus urged by the blowpipe, the extreme heat is just at the tip of the outer white flame, where the combustion is most perfect, and where substances are rapidly burned or oxidised; whilst the interior blue flame, in consequence of its excess of combustible matter, abstracts oxygen from, or *reduces*, substances. So that several metals, when thus heated before the blowpipe, are alternately oxidised and deoxidised by being placed in the outer and inner flame. The blowpipe is of important service to the chemist in enabling him to ascertain easily and quickly the effects of intense heat upon a variety of substances; and he frequently has recourse to it in order to distinguish metallic and earthy minerals from each other, and to ascertain in a general way the nature of their component parts: it is, in fact, a most important auxiliary in all cases of qualitative analysis. Several treatises have been written on the use and indications of the blowpipe: the reader is especially referred to Faraday's *Chemical Manipulation*, sect. iv. § 3.

Blubber. The cellular membrane in which the oil or fat of the whale is included. [BALÆNA.]

Blue (A.-Sax. bleaw; Ger. blau). In Painting, the colour of the sky. It is one of the original or prismatic colours, and is of many sorts: the principal are ultramarine, prussian blue, blue bice, and indigo.

Blue Iron-ore. [VIVIANITE.]

Blue John. The name commonly given by the miners of Derbyshire to the beautiful variety of compact Fluor Spar, which is made into vases and other ornamental articles. The finest kind for these purposes is found at Tray Cliff, near Castleton.

Blue Lead. Is a name applied by miners to Galena, in contradistinction to White Lead-ore, Anglesite, &c. The name *Blue Lead* is also given to a pseudomorphous variety of Galena, found in Cornwall and elsewhere, accompanying the carbonates of lead and copper.

Blue Light. A composition consisting of saltpetre 4 parts, sublimed sulphur 2 parts, red orpiment 1 part. It is used for signal purposes.

Blue Mould. The name given to *Aspergillus glaucus* as it appears growing on cheese, and perhaps applied also to some other kindred moulds. Though often purposely induced on cheese, it may be considered as of doubtful wholesomeness.

Blue Pill. *Pilula hydrargyri.* Consists of mercury triturated with conserve of roses and the powder of liquorice root till the globules disappear and a homogeneous bluish-grey pill-mass is obtained: it contains one-third of its weight of mercury.

Blue Prussian. [PRUSSIAN BLUE.]

Blue Stone or **Blue Vitriol.** Sulphate of Copper.

Bluffs. High banks presenting an abrupt form towards the sea or river.

Boa (Lat.). A genus of serpents, with the transverse scutæ of the abdomen and tail in a single row, and without a rattle or spur at the end of the tail. Some species attain an immense size; but the large serpents brought to this country, and called boa constrictors, are generally *Pythons*, and natives of Asia. The true boas are from South America.

Boar. [Sus.]

Board (A.-Sax. bord). A word applied usually to certain individuals in a collective capacity, who are intrusted with the management of some public office or department. Thus the Commissioners of Customs, the Committee of the Privy Council for the Affairs of Trade, the Commissioners of Excise, &c. when assembled to transact the business of their respective offices are styled the Board of Customs, the Board of Trade, the Board of Excise, &c. But the term Board is used also in a more general sense, being applied to any individuals appointed by competent authority to deliberate on or superintend the operations of any private business or speculation.

Board. Timber cut up into thin stuff is usually known as board, though in the case of elm and fir the thicknesses called *boards* become *planks* when applied to mahogany or oak. The term board is applied familiarly to a piece of timber of 9 inches wide and 3 inches thick; but strictly speaking the term should not be applied to a greater thickness than 1½ inch. The word board is used to express also the purposes to which timber may be converted in a building, such as barge board, eaves board, floor board, &c.

Boarding. In Naval language, is the act of attacking a hostile ship by the introduction of armed men upon its decks. The operation is always attended with risk, from the confined nature of the battle-ground, ignorance of the enemy's dispositions, &c. Unless the boarding is in the nature of a surprise, and therefore conducted by boats, it is essential as a preliminary that the ships should be laid alongside or athwart each other.

Boat (A.-Sax. bât). A term used in a general sense to denote any small ship or vessel, whether open or decked, and which may be propelled by oars, or by sails, or by steam. Boats are accordingly of very different forms and constructions, according to the different purposes they are intended to serve. Under this term are comprehended barges, cutters, pinnaces, yawls, &c. [Ship; Steam Navigation.]

Boatswain (A.-Sax. bâtswan). The second of the three warrant officers of a man-of-war; he has charge of the boats, rigging, anchors, and cables. It is his duty to *turn the hands up*, or summon the whole crew, whenever they are required for any duty. He should from the nature of his duties be an active man, and a thorough seaman. The *boatswain's mates* assist the boatswain, summon the watches or other portions of the crew to duty, and inflict punishments.

Bobstays. Stays or strong ropes to keep down the bowsprit during the plunging of the ship, and against the upward action of the head sails (jibs, fore-staysail, &c.), and to sustain the action of the stays or ropes, which keep the foremast, fore-topmast, &c., and therefore the main-topmast, from falling aft. They are necessarily very strong; they are attached to the bowsprit by *collars* placed about two-thirds of its length outside, and to the hull of the ship, by passing through holes in the *cutwater* or projecting head, and make an angle of about 30° more or less with the axis of the bowsprit. They are often made of chains.

Boccius Light. A form of gas-burner invented by Boccius, in which two concentric metal cylinders are so placed over the flame, and within the usual lamp glass, as to modify the combustion and increase the proportion of light.

Bocland (A.-Sax.). Land held by *book* or charter. Lands so held were estates of perpetual inheritance, as distinguished from *folcland*, which, as being the property of the community, might be granted to persons in the folc-gemot, but which at the expiration of a given term reverted to the community. Folcland was subject to many burdens from which bocland was exempt. The latter obliged the owner to contribute only to military expeditions and the repair of castles and bridges—an obligation expressed by the term *Trinoda necessitas*. The word folcland, falling into disuse, was replaced by the term *terra regis* or crown land. (Allen, *On the Royal Prerogative*; Hallam, *Middle Ages*, chap. viii. note 9.)

Bodenite. A kind of Allanite found in prismatic crystals at Boden, in the Saxon Erzgebirge.

Body (A.-Sax. bodig). In Geometry, is synonymous with *solid*. Thus we say the five regular *bodies*, or five regular *solids*. [Solids.]

Body. In Physics, is a term applied to any portion of matter of which the existence can be perceived by any of our senses. According to the Peripatetics, body is composed of *matter*, *form*, and *privation*. In modern physics, body is regarded as an agglomeration of material particles. According to the different forms in which matter exists, bodies may be *solid*, *liquid*, or *gaseous*.

Body of the Place. [Enceinte.]

Bog (Gael. *soft*). The name given in Natural History to a collection of peat earth and vegetation, or to an accumulation of peaty soil under the influence of rain or of running waters. The soil thus collected is composed principally of silica and vegetable fibre. On the Continent, bog earth is worked for peat under the names of *lager veen* and *hoog veen*, the lower or the higher peat, according as the mass may occur with respect to the water line of the country; the *hoog veen* is usually considered to be the more valuable of the two, on account of the smaller quantity of water it contains. Many

human remains and relics of animals have been discovered in bogs, which possess a strange antiseptic power.

Bog Butter. A variety of Hartite or Guayaquilite found in the peat-swamps of Ireland.

Bog Earth. A soil consisting chiefly of sand and vegetable fibre; it is often accumulated in considerable quantity where waters have deposited the mud in boggy places. Many American shrubs and other plants and flowers will thrive only in such or similar soils, so that bog earth is in great request for such purposes. It may, to a certain extent, be artificially imitated by mixing the cuttings of grass with the mud of ponds and a sufficient quantity of sharp sand.

Bog Iron-ore. A hydrous oxide of iron common in flat marshy localities. It is of variable composition, containing from 20 to 70 per cent. of peroxide of iron: the protoxides of iron and manganese are often present, and sometimes as much as 10 per cent. of phosphoric acid and organic matter.

Large quantities of the skeletons of Infusoria (*Gallonella ferruginea*) have been found by Ehrenberg in the Bog Iron-ores of Prussia, the Ural, and New York. The infusoria of the Bog Iron-ore are stated by Ehrenberg to be only one-thousandth of an inch in diameter, or half that of a human hair—consequently a cubic line would contain 1,000,000,000 of those minute organisms. [LAKE ORE.]

Bog Manganese. Earthy Manganese or *Wad* [which see].

Bog Ores. [BOG IRON-ORE; LAKE ORE; &c.]

Boghead Coal. A highly bituminous variety of the Parrot or Cannel Coal of Scotland from the higher part of the Scotch coal-field worked at Boghead, near Bathgate in Linlithgowshire.

The bituminous varieties of cannel pass into bituminous shale by insensible gradations, so that it is impossible to draw a line of separation which shall properly limit the use of the term *coal*. The Boghead is one of these substances, much more valuable for gas-making and for the oils and paraffine obtained from it, on slow distillation, than for fuel in the ordinary sense of the term. Dr. Andrew Fife found a picked specimen to yield on analysis 70 per cent. of volatile matter and 30 per cent. of ash. [BITUMINOUS SHALE; CANNEL COAL.]

Bohea. [TEA.]

Bohemian Bole. A yellowish red variety of Bole.

Bohemian Diamond. A name sometimes given to colourless and transparent Rock Crystals, when cut and polished.

Bohemian Garnet. [CARBUNCLE; PYROPE.]

Bohemian Ruby. [ROSE QUARTZ.]

Bohemian Topaz. Transparent yellow Rock Crystal.

Böhmeria (named in memory of Böhmer, a German botanist). A genus of Nettleworts, consisting of herbs or shrubs closely allied to the true nettles, but not having stinging hairs. *B. nivea* is the Rheea or Chinese grass-cloth, the fabric so called being prepared from the inner bark of the stems. It is a small shrub remarkable for the whiteness of the under surface of its leaves. It is much cultivated for its fibre in China and India. Other species yield useful fibres.

Boiler. The term used in Civil Engineering to express the vessel in which water is boiled for the purpose of raising steam for the machinery of a factory; or a closed vase of wrought iron, or copper, in which water is vaporised, and employed in the gaseous form, to impress movement upon steam-engines or other machines. In this case, the effect of the machine is dependent upon the conversion of the water into vapour, and this power is the only one used. The boiler must then satisfy certain conditions which are of the highest interest. Thus, as the motive power of the engine depends upon the excess of the pressure of the steam in the boiler, it is necessary that the latter should be of sufficient strength to resist it; and as the heat applied is always more or less costly, it is important that the fireplace should be constructed so as to employ the whole of it. The danger of allowing the boiler to sink so low as to let the metal come in contact with cold water admitted suddenly, must also be carefully guarded against, and this necessity gives rise to many contrivances of a complicated nature.

The parts of a boiler, ordinarily, are: the furnace, consisting of the fire-bar, the ash pit, and the bridge; the boiler properly speaking, with its steam chest and pipe, and its safety-valves; the apparatus for ascertaining the level of the water and its pressure in the boiler, which consist in the steam gauges, and the pressure gauge or manomètre; the float and tubes; and the chimney. Each of these parts has a separate use, and it requires a special adaptation to the class of engine under consideration; for the purposes of ordinary commerce some of the parts may be omitted, but they must all be present in steam-engines, and must be modified according to whether the boiler is intended to work at high, or low, pressure. Many varieties have been proposed in the manner of heating the water contained in the boilers; and as the heat developed in the furnace acts more by the extent of the surface to which it is applied than by its intensity, every form has been recommended for this purpose in its turn; but, after all, it seems that local considerations are of more weight in deciding the kind of furnace than any abstract ones, and the style which might suit at one place would not suit at another. The principal forms of furnace are referred to in the subsequent parts of this work, and the same remark may be extended to the other details; because there are no universal principles regulating their construction, which would admit of being laid down authoritatively. The most common

forms of boiler used are the waggon-head, the cylindrical, the tubular, and the locomotive boilers [all which see]: the parts which are connected with the level of the water, the pressure of the steam, and the draught in the chimney will be found investigated under WATER and STEAM GAUGES; BRINE COCKS; FLOATS; and CHIMNEY.

For heating water for the purpose of warming buildings, the boilers are very frequently made of copper, or of cast iron, when the quantity of water to be heated is small, or of wrought iron when it is greater; the latter material is, however, so generally used that it is alone worthy of notice.

Boiler Plate. The description of wrought iron which is rolled expressly for the purpose of boiler-making; though by a common error it is made to apply to the plates which are used for ship-building, bridges, or girders; all of which are now said to be constructed in boiler plates. The average resistance of boiler plates is taken at about 20 tons on the square inch, and the safe weight to which it may be loaded is usually taken at 5 tons on the square inch; the effect of riveting upon the structure is considered to be equivalent to a reduction of strength corresponding to that of the area occupied by the rivets. The Board of Trade require that the strength of wrought-iron structures should be at least equal to the above quantity of 5 tons per square inch.

Boiling Point. The temperature at which liquids are rapidly converted into vapour with the phenomena of *ebullition*. Thus the boiling point of water is 212°; of alcohol, 176°; of ether, 96°; of oil of turpentine, 316°; and of mercury, 662°; these being the respective temperatures at which these bodies continuously pass into the state of vapour.

Bole (Gr. βῶλος, *a clod of earth*). An earthy argillaceous mineral chiefly consisting of hydrated bisilicate of alumina, reddened by peroxide of iron; as is the case in *Armenian Bole*, which is used in tooth-powder and as a colouring material. It is found in Saxony, Silesia, Bohemia, Sicily, &c.

Bole of Blois. A yellow kind of Bole, which contains carbonate of lime, and effervesces with acids.

Bolero. A peculiar species of dance very popular in Spain, and so called from the name of its inventor.

Boletic Acid. An acid contained in the juice of the *Boletus pseudo-igniarius*.

Boletus (Lat.). A genus of *Fungi*, many large species of which spring from the sides of trees when the rind is decayed, forming firm fleshy masses, which are generally smooth on the upper side, and pierced with holes on the lower. The spawn of such plants often forms what is called dry-rot, insinuating its fine delicate filamentous ramifications between the tubes of the wood, forcing them asunder, and so destroying the cohesion and solidity of timber. *B. igniarius* and *B. fomentarius* are the fungi which, when cut into thin slices, dried, and prepared with saltpetre, form common amadou, or the German tinder of the shops. *B. tuberosus* is used in Sweden as a substitute for cork. *B. bovinus* is said to be a favourite food of oxen, deer, swine, and some other animals; it is even used for human food. *B. edulis*, though not much used in this country as an article of food, is in Hungary preferred to the mushroom.

Bollards. Are large posts set up on either side of a dock, or basin, for the purpose of having attached to them the blocks through which are reeved the hawsers used in hauling vessels into and out of the dock.

Bologna Phials. Small flasks or phials of unannealed glass which fly into pieces when their surface is scratched by a hard body, as by dropping into them a fragment of flint; whereas a bullet may be dropped into them without injury.

Bolognese School. In Painting, there were three periods of the Bolognese school; the Early, the Roman and the Eclectic. The first was founded by Marco Zoppo in the fifteenth century, and its great master was Francia. The second was founded in the sixteenth by Bagnacavallo, who spread the Roman style in Bologna; the masters of this period were Primaticcio, Pellegrino Tibaldi, and Niccolo dell' Abate. The third was founded by the Carracci at the close of the sixteenth century; its object was to unite all the excellences of the preceding schools [PAINTING]; hence it is called the *Eclectic school*. Among the principal painters which it numbered were Domenichino, Lanfranco, Guido, Schidone, Guercino, Albani and others known as the *Carracceschi*. Their merits were purely technical, and their style Academic.

Bolognian Stone. A kind of sulphate of baryta found near Bologna. After having been heated with charcoal, and then exposed to the light of the sun, it becomes strongly phosphorescent, and remains so for some time.

Boloretin. An earthy-looking resin, contained in the fossil fir-wood of the peat bogs of Denmark.

Bolster. In Nautical language, has three meanings. 1st. A piece of timber adjoining the hawse-hole, intended to prevent the chafing of the hawser against the cheek of a ship's bow; 2nd. Small pads of painted or tarred canvas placed under the rigging to prevent friction when the spars strain in stormy weather; 3rd. A cylindrical iron block, with a hole through the middle, used as an anvil when holes are being punched in metal.

Bolt-rope. The border of the sails of a ship, to strengthen the canvas and prevent it tearing. Up the sides of a sail it is a *leech-rope*, along the top a *head-rope*, and at the foot a *foot-rope*.

Bolts, Naval. Are cylindrical rods of copper or iron, preferably copper, employed in binding together the timbers or iron plates of which a ship is constructed. They vary from half an inch to three inches in diameter, and

in length from a few inches to many feet. Their heads are of diverse patterns, according to the object for which they are intended.

Bolthead. A globular flask with a tubular neck, used in the chemical laboratory.

Boltonite. A kind of Chrysolite, which differs from the other varieties of that mineral in being a silicate of magnesia, instead of a silicate of magnesia and iron. It occurs at Bolton in Massachusetts, in granules and irregular masses disseminated through limestone, seldom with any traces of crystalline form, and of a colour varying from ash-grey to yellowish-white: the darker colours change to yellow on exposure to the weather.

Bolus (Lat. from Gr. βῶλος). A very large pill; or a medicine formed into an olive-shaped mass, not too large to be swallowed.

Bomb. [Shell.]

Bomb Vessel. [Ketch and Mortar-boat; Gun-boat.]

Bombardier (Fr., from Low Lat. bombarda). The name given to the lowest rank of non-commissioned officers in the artillery.

Bombardiers. [Brachinus.]

Bombardment. A term signifying the showering down upon a town or fortress shells, carcasses, rockets, hot shot, and other incendiary missiles, to burn or destroy the buildings and kill the inhabitants. It takes effect more upon the civilians than the military, as the latter in any well-constructed place are lodged in bomb-proof buildings. That a bombardment is of little avail against a governor who is firm may be seen from the memorable bombardment of Prague during twenty-two days in 1757 by Frederick of Prussia; also those of Williamstadt by the French in 1793, and Gibraltar in 1780–81. Before bombarding a town, it is customary to give notice, to allow women and children to leave it.

Bombax. A genus containing many species of large soft-wooded trees, whose capsules are filled with a fine cottony substance enveloping the seeds. It belongs to the natural order *Sterculiaceæ*, of which *Bombaceæ* is a subdivision. In this order, which is allied to the Malvaceous plants, it is associated with the celebrated Baobab, and many more gigantic inhabitants of tropical forests. The Bombax trees are remarkable for forming huge buttresses, projecting from the parent trunk. The quantity of cotton yielded by these trees is enormous; but it is unfortunately of too short a staple to be used for manufacturing purposes. This substance bears the name of Silk-cotton.

Bombazine (Gr. βόμβυξ, *a silkworm*). A fabric of which the warp is silk, and the weft (or shoot) worsted. It is chiefly made in black, and is an article of mourning for female dress.

Bombic Acid. The acid contained in the silkworm, especially in its chrysalis state. It is supposed to resemble formic acid.

Bombite. A mineral with all the characters of Touchstone, of which it is, probably, only a variety. It is found in the environs of Bombay (whence the name).

Bombycilla. A genus of omnivorous Passerine birds, of which the Bohemian wax-wing (*Bombycilla garrula*) is an example, and an occasional winter visitor of Britain.

Bombylius. A Linnæan genus of Dipterous insects, and now the type of a family (*Bombyliidæ*), characterised by the great length of the oral instruments, which form a long and slender proboscis; body thick, short, hairy; thorax gibbous; wings extended horizontally; halteres exposed; antennæ short, approximate, composed of three joints, the last the longest, thickened and terminating obtusely; legs long and slender. The insects of this family have a rapid flight, and are very active; they subsist entirely on the nectar of flowers. They are of small size, and mostly exotic, affording types of many genera, of which only *Bombylius* proper and *Pthiria* afford British examples.

Bombyx (Gr. βόμβυξ, *a silkworm*). A Linnæan genus of Lepidopterous insects, now the type of a family (*Bombycidæ*), including many genera of nocturnal and postmeridian moths. These have been arranged under the following sub-families: *Hepialidæ*, *Notodoxidæ*, *Arctiidæ*, and *Bombycidæ* proper.

Bona (Lat. *goods*). In Law, *Bona notabilia*, goods to the value of five pounds, whereof if a man died possessed in two dioceses respectively his will must formerly have been proved before the metropolitan of the province. [Probate, Court of.] *Bona vacantia*, goods without owner, such, for instance, as goods casually lost: the property whereto, the law of England and some other countries vests in the crown.

Bona Dea (Lat.). In Roman Mythology, a goddess described as sister or daughter of Faunus. The Bona Dea had two sanctuaries at Rome, the one on the Aventine, the other near Bovillæ (Cic. *pro Milone*, 31), but her rites were generally solemnised in the house of the consul or prætor. In the celebration only women participated. The violation of these mysteries by P. Clodius in the house of Cæsar, his trial, and his acquittal, which he had purchased by bribery, are well-known facts. (Cic. *Att.* i. 12.)

Bonassus. [Bison.]

Bond (A.-Sax.). In Building, the disposition of the materials in a wall in such a way as to exhibit homogeneity of structure. There are many ways of producing this effect, which are known technically by the following names. The *English bond* is used in brickwork where all the headers of a course of bricks are laid in one way, and all the stretchers in the course over it are laid in the other, so that the union of the bricks is made by the reverse positions of the several parts in the successive courses. *Flemish bond* is the one used in brickwork where the headers and stretchers are alternately laid in the same course, so that the union is effected in the course itself. When stonework is employed, *bond stones* are used, which run through the whole thickness of the wall at right angles to the face, for the purpose of binding the wall together in the direction of its thickness; and in mixed structures timber

is used as a *bond course*, being worked in the wall in the progress, for the purpose of tying it together in a longitudinal direction. In slating, the term *bond* is sometimes applied instead of lap, and it signifies in such cases the distance between the nail in the under slate and the lower edge of the upper or covering slate.

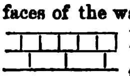
Bond. In Law, a deed whereby the obligor, or party binding himself, obliges himself, his heirs, executors, and administrators, to pay a certain sum of money, called the penalty, to another (the obligee) at a day appointed. There is a condition added, that if the obligor does some particular act the obligation shall be void, or else remain in full force. In case this condition is not performed, the bond becomes forfeited or absolute at law, and charges the obligor while living; and after his death the obligation descends on the heir, who (in default of personal assets in the hands of the executor or administrator) is bound to discharge it, provided he have real assets by descent. The condition is usually (although not necessarily) included in the same deed, and at the foot of the obligation.

A bond without a condition is termed single (or *simplex obligatio*); and it becomes single by forfeiture, on non-performance of the condition. At law, the whole penalty mentioned in the bond was recoverable on such non-performance. But by the interposition of equity the obligee was discharged from paying more than the sum to which the obligor was reasonably entitled; viz. his principal, interest, and expenses, if the bond was for payment of a debt; or the damages accruing to him, if it was for the performance of a stipulated act. But by 4 & 5 Anne c. 16, it was enacted that in case of a bond conditioned for payment of money, the payment of the sum due, with interest and costs, even though the bond be forfeited and suit commenced thereon, shall be a full satisfaction and discharge; and on this footing the law now stands.

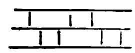
A bond on which neither principal nor interest has been demanded for twenty years will be presumed to have been satisfied; but length of time is not, strictly, a legal bar, but only a ground for the jury to presume satisfaction.

In a bond where several are bound severally, the obligee may, at his election, sue all the obligors together, or all of them apart, and have several judgments and executions: but he shall have satisfaction but once; for if it be by one only, that is sufficient to discharge the debt.

Bond, English. In Architecture, that disposition of bricks in a wall wherein the courses are alternately composed of *headers*, or bricks laid with their heads or ends towards the faces of the wall, and in the superior and inferior courses of *stretchers* or bricks, with their lengths parallel to the faces of the walls, as in the margin, in which the upper is called the heading, and the lower the stretching course.



Bond, Flemish. In Architecture, that disposition of bricks in a wall wherein each course has headers and stretchers alternately, as in the margin.



Bond Stone. In Architecture, a stone running through the whole thickness of a wall at right angles to its face, for the purpose of binding the wall together in the direction of its thickness.

Bond Timber. In Architecture, timber worked in with a wall as it is carried up, for the purpose of tying it together in a longitudinal direction while the work is setting.

Bone (Ger. bein; Dutch, been). An important part of the higher orders of animals [Anatomy], forming the solid support of their fabric, and protecting the vital organs, such as the brain and the heart and lungs, from external pressure and injury. In the human skeleton there are commonly enumerated 260 distinct bones. They, however, admit of classification under three heads; namely, *long* or *cylindrical* bones, such as those of the extremities; *broad* and *flat* bones, such as those of the skull; and *short*, *square*, *irregular*, or *solid* bones, such as the vertebræ, and those of the wrist and instep, and the patella or kneepan. The first bones are generally filled with marrow, and are admirable specimens of strength of structure with the least possible weight. The bones are covered by a membrane called *periosteum*, by which the ramifications of blood-vessels and nerves pass into the bone. In the growth of a bone, the cartilaginous portion, as it has sometimes been called, is first formed, and the earthy or indurating part is afterwards deposited. The soft parts consist of modified gelatine and albumen; and the hard portion is composed of phosphate of lime and carbonate of lime, with small quantities of other salts. The animal matter of bones amounts on an average to about half their weight, or, when dried, to between 30 and 40 per cent.; so that they contain a large relative proportion of nutritive matter. The bones, including their animal matter, are the most durable parts of the animal fabric; hence the proposal of storing them up, as occasional sources of nutriment; for not only is the cartilaginous portion unimpaired in bones which have been kept dry for many years, but it has even been found perfect in bones of apparently antediluvian origin. The best mode of extracting the nutritious part of bone for human food consists in grinding it fine, and subjecting it with water to a heat of about 220° in a digester; or the earthy part may be removed by dilute muriatic acid. When dogs and some other animals devour bones, the nutritive part is abstracted by their gastric juice, and the earthy part is voided in their excrement, forming what was formerly called *album græcum*. [Bone Earth.]

When bones are submitted to destructive distillation, the animal matter which they contain is abundantly productive of *ammonia*;

hence a copious source of that alkali and its compounds. The residue is a mixture of the earthy part of the bone with charcoal, commonly termed *ivory* or *bone black*.

Bone Bed. Several deposits of different geological age have been thus named. The most remarkable are two; first, a singular mass of scales, fins, jaws, teeth and coprolites of fishes, found in the Upper Ludlow rocks, and secondly, a thin but well-marked accumulation of reptilian bones between the lias and new red sandstone at Aust in Gloucestershire. The latter is now recognised as belonging to the Triassic period.

Bone Black. The black carbonaceous substance obtained by heating bones to redness in a close vessel. When deprived by the action of hydrochloric acid of the phosphate of lime with which it is blended, it yields one of the most valuable forms of *animal charcoal*, as a decolouring and deodorising material.

Bone Dust (or ground bones). Has long been used with the best effect as a manure. It is usually applied to light or turnip soils, which it has rendered in no ordinary degree productive. The importation of bones from distant countries to be used as manure is carried on to a great extent. Bone dust is now used very generally after being subjected to the action of sulphuric acid. The superphosphate of lime, as it is then called, is more immediate in its effect on fertility; and 3 cwt. of it will produce as great an increase in the current crop, as 12 to 20 bushels of the original bone dust formerly applied could do. It is generally applied to the turnip crop, to mangold wurzel, and occasionally to grass lands.

Bone Earth. The residue of bones which have been calcined so as to destroy the animal matter and carbon, and become converted into a white porous and friable substance, composed chiefly of phosphate of lime. According to Berzelius, 100 parts of human bones are composed of 51·04 phosphate of lime, 11·30 carbonate of lime, 2 fluoride of calcium, 1·20 soda and chloride of sodium, 1·16 phosphate of magnesia, and 33·30 animal matter. Albumen, gelatine, and fat constitute the animal part of bone, the greater part of which remains in the form of a tough cartilage when bones are steeped in dilute muriatic acid.

Bone Liquor. The aqueous portion of the distillate of heated bones. It is a very impure and dilute solution of various ammoniacal salts, resembling *spirit of hartshorn*.

Bonito (Span.). The name of a species of Scomberoid fishes (*Thynnus Pelamis*, Cuv.), common in the tropical ocean, and well known to voyagers from its persecution of the flying-fish (*Exocetus volitans*) and flying squid (*Loligo sagittata*).

Bonnet. [FORTIFICATION.]

Bonsdorfite. A hydrated variety of Iolite, of a dark olive-green or greenish-brown colour, found at Abo with Cordierite. Named in honour of the chemist Bonsdorff.

Bonzes. The priests of the religion of Fo are so called by Europeans; especially in China, the Burman Empire, Japan, and other districts of Eastern Asia.

Booby. The English name of a genus of *Pelecanidæ*; they are also called gannets, noddies, and solan geese.

Book (A.-Sax. boc). The general name of almost every literary composition, but in a more limited sense applied only to such compositions as are large enough to form a volume. Short and fugitive pieces are denominated pamphlets, in contradistinction to books, which are of greater length, and embrace more general or permanent topics. According to their sizes and forms, books are distinguished as folios, quartos, octavos, duodecimos, &c. The materials of which books have been composed have differed much in different nations, and in different stages of civilisation. Plates of lead and copper, bricks, stone, and wood were anciently employed for this purpose. At a later period the bark of trees formed the chief material, as is indicated by the meaning of the words which in some languages are employed for the term *book*. The materials for books were afterwards derived from the Egyptian plant papyrus; but as the demand increased, more durable materials were sought for, and leather, made chiefly from the skins of goats or sheep, was employed for this purpose. Next followed the use of parchment, on which the ancient MSS. were chiefly written: but all these systems were swallowed up by the invention of paper [which see], which took place about the thirteenth century, and facilitated the circulation of knowledge to an incalculable extent. The first books were in the form of blocks and tablets; but when flexible materials came into use, it was found more convenient to roll them up in scrolls, called by the Romans *volumen*. Books were anciently written on one side only of rolls of paper or parchment. When written on both sides they were called *opisthographi* (Plin. iii. 5; Juv. i. 5). The blank backs were usually stained with the saffron colour obtained from the cedrus (Ovid, *Trist.* iii. 1. 13). To save the expense of writing materials it was unfortunately sometimes the custom to wash out what were considered unimportant writings, and use the paper or parchment again. These were then called *palimpsests*. [PALIMPSESTS.]

Book-keeping. In Commerce, the art of recording, in a regular, concise, and systematic manner, the transactions of merchants, traders, or other persons engaged in pursuits connected with money. It has not only the authority of experience to recommend it, but that of some of the sagest observers of human affairs; Dr. Johnson remarks, 'that the counting-house of an accomplished merchant is a school of method, where the great science may be learned of ranging particulars under generals, of bringing the different parts of a transaction together, and of showing at one view a long series of dealing and exchange. Let no man (he adds) venture into large business while he is ignorant of the method of regulating books; never let him imagine that any degree of

natural abilities will enable him to supply this deficiency, or preserve a multiplicity of affairs from inextricable confusion.' There are two modes of keeping books of account; the one by what is termed *Single* and the other by *Double Entry*. Both are in very general use. The system of single entry is chiefly confined to the business of retail dealers; it is much the simplest method of book-keeping, consisting of only a day-book and a ledger. In the day-book the dealer enters his sales and purchases, and in his ledger he carries the former to the debit of his customers, and the latter to the credit of the merchants who supply him with goods. By making at any time a list of the sums due to him by his customers, and of those due by him to wholesale merchants, the retail dealer may, after adding to the debts due to him the value of his stock on hand, arrive at an approximation to the real state of his debts and assets. This, however, is but an imperfect and unsatisfactory mode of book-keeping; and, therefore, in the case of wholesale and mercantile business, where extensive and multifarious transactions have to be recorded, recourse is had to the system of *double entry*. This system possesses all the advantages of single entry, besides being so complete and comprehensive in its principles, and so certain in its results, as to admit of universal application. It may with equal advantage be adopted in the most limited as well as in the most extensive, in the most plain and simple as well as in the most intricate and complicated concerns.

No very authentic accounts exist of the origin of book-keeping. The double-entry system appears to have been first practised towards the latter part of the fifteenth century, in Venice and other towns in Italy, then the great emporium of the mercantile world; and from this circumstance it acquired the name of the *Italian method of book-keeping*. The first known work on the subject was by Lucas de Borgo, published in 1495; and the first in the English language a treatise by John Gough, a printer, published in London in 1543. The advantages of the system, and the soundness of the principles on which it is based, soon became apparent; for we find it was adopted in England and France early in the sixteenth century, and has continued to be more and more practised down to the present day.

The great objects of a good method of book-keeping are to exhibit transactions as they occur, in the most minute detail, and ultimately in the most condensed form; advancing from the earliest stage to the latest by such clear and lucid steps as at all times to admit of every fact being traced in its progress, and security being obtained at every step against omission or error. For the attainment of such important objects, no mode of book-keeping has hitherto been devised at all approaching to the perfection of the Italian system by double entry. Every transaction in business is twofold; there can be no receipt without a payment, and no purchase without a sale, and consequently by presenting the same event or fact on both sides of the books, whence the name of 'double entry,' the entries being simultaneous, become corroborative of each other. The circumstance of every transaction being entered on both sides of the ledger affords one of the most valuable results derived from the system of double entry, namely, a test of accuracy; inasmuch as the entries on the credit side must be equal to the entries on the debit side, otherwise the books will not balance.

The three principal books required under the Italian system of double entry are, a cash book, journal, and ledger. In the first of these every transaction is recorded where money forms one of its elements, and in practice these transactions are by some book-keepers carried direct from the cash book to the ledger without being passed through the journal at all. The journal, however, forms a most important part of the system. It exhibits a narrative of every transaction of which an actual transfer of money does not form one of the elements, arranging the facts in as simple and condensed a form as correctness and intelligibility will admit of, and the results of those entries in the journal are afterwards introduced into the ledger, which thereby becomes a sort of key to the detailed history of every transaction; whilst at the same time it furnishes a luminous compendium of the whole. In like manner when the cash transactions are passed through the journal they are at stated periods classed and arranged in a condensed form, and thence transferred to the ledger. This plan of introducing the cash transactions into the journal is considered much the best system, though attended with a little more trouble to the book-keeper, as it affords great facilities in balancing the books and testing the accuracy of the ledger, more particularly when the recent improvements upon the form of the journal, which were originally suggested by the late Mr. Jones, are adopted. By the plan referred to, the journal is advantageously ruled with four cash columns, two upon the left-hand side for *entries debtor*, and two upon the right for *entries creditor*; and all the transactions being connected either with *personal* and *property* accounts or *nominal* accounts, such as charges, profit and loss, and so forth, they are classed accordingly in the columns on the Dr. or Cr. side of the journal respectively; and as the debit entries are at all times equal to the credit entries, the aggregate of the two columns on the Dr. side must tally with the aggregate of the two on the Cr. side of the journal. This too is found in practice to be a most useful check against posting the entries to wrong accounts in the ledger; for on balancing the books, by taking the amounts Dr. and Cr. posted to personal and property accounts, and the amounts Dr. and Cr. posted to nominal accounts in the ledger, and comparing them with the total amounts in the corresponding columns of the journal, it will be seen whether they agree: if they do

not, it demonstrates that some entries must have been erroneously posted, which can then only be discovered by collating the books; but if the amounts do agree, then it affords at least strong presumptive evidence that the whole of the entries have been carried to the proper accounts. Experience and practice are occasionally suggesting minor improvements upon the forms of the cash book, journal, and ledger, to suit particular cases, as well as upon the subsidiary books required for gathering together the facts preparatory to their being transferred in a condensed form into the journal; and indeed an intelligent book-keeper may accomplish much by a judicious classification of the facts in the auxiliary books; but the fundamental principles of the double-entry system of book-keeping, notwithstanding such occasional facilities and improved arrangements in the working of it, remain perfect and unchanged; and after the length of time during which they have successfully withstood all attempts at innovation or change, it may safely be affirmed that the system is the best hitherto discovered.

We have already stated that the double-entry system of book-keeping admits of universal application; and we may now observe that it is not confined to merchants' accounts, but is equally applicable to government accounts. One great desideratum in a system of book-keeping for government accounts is centralisation, which can alone be attained by a proper and well-organised method of condensing the facts or elements of the accounts; and the Italian system unquestionably affords the most efficacious means of collecting and grouping the widely scattered elements of government accounts in a concise and intelligible shape, and ultimately exhibiting them in the clearest and most perfect state.

Boom (Ger. baum, *a tree* or *pole*). A Nautical term, signifying a long pole run out from any part of a ship to stretch the bottoms of particular sails; whence *jib-boom*, *main-boom*, *studdingsail-boom*, &c.

Boom. In Marine Fortification, signifies a strong chain or cable stretched across the mouth of a harbour or river, to prevent the enemy's ships from entering, and having a number of poles, bars, &c. fastened to it; whence the name.

Boomerang. A familiar though little understood missile, of a curved form, which in the hands of a native of Australia performs marvellous feats, while in those of a European it is inert and intractable. The savage by practice knows precisely how to poise as well as project his familiar missile; and in this secret of the *balanced* centre consists Sir Thomas Mitchell's application of the principle of the boomerang to the propulsion of vessels. Great results are anticipated from the scientific application of this simple principle, suggesting as it does a means of adapting a surface revolving round a centre, so that it presents to equal pressure a uniformity of resistance, because the spaces described by a body in falling are proportional to the squares of the times. When the same surface is placed vertically and set in rotary motion through fluids, it is subject to a similar law, and when in the plane of a screw, it is equally poised obliquely. Thus we have in this form equilibrium, and equal resistance, and equal strength, the propeller being balanced when it is first formed on its axis. Hence, under any degree of velocity centrifugal action is converted into concentric action by the peculiar manner of balancing the surface round the centre of rotary motion.

Boops. A genus of fishes of the order *Acanthopteri*; most of them occur in the Mediterranean.

Boort or **Bort.** A kind of Diamond, generally of a spherical shape, and apparently formed of a confused mass of interlaced and twisted parts, like knots in wood. In consequence of this peculiar structure, it cannot be cut like the ordinary diamond, and is only of use for polishing other stones, after it has been broken and reduced to powder in a mortar.

Boötes (Gr. *a ploughman*). A name given to the constellation Arcturus, as early as the Homeric age. (*Odys.* v. 272.)

Boracic Acid. This substance is abundant in the crater of Volcano, one of the Lipari Isles, and around the fumaroles of Tuscany [SASSOLIN]: it also occurs in some minerals. In its usual scaly state it is a *hydrate*, composed of 56·4 per cent. of dry acid + 43·6 water. It is used for making borax, and was formerly known under the name of *Homberg's sedative salt*. [BORON.]

Boracite. Native borate of magnesia. It occurs in cubes, inclining to grey, yellow, or green, with a vitreous lustre, and opaque or more or less translucent. Small but perfect crystals are found at Kalkberg and Schildstein, near Lüneberg, in Hanover, in beds of Gypsum; and it is also met with massive at the salt-mine of Stassfurth in Prussia.

Boraginaceæ. A group of corollifloral Exogenous plants resembling the genus *Borago*, after which they are named. They usually have a mucilaginous sap, in which nitre exists in small quantities. Boraginaceous plants are mostly herbs of the northern temperate regions, and they have sometimes very handsome flowers, arranged in a gyrate manner. Forget-me-not (*Myosotis*), Bugloss (*Echium*), *Anchusa*, and various species of *Lithospermum* are well-known favourites either among wild or cultivated plants. Most of them have their leaves covered with asperities, whence their old name of *Asperifoliæ*; and some, as *Anchusa tinctoria*, *Lithospermum tinctorium*, and several others, yield a deep purple dye from their roots.

Borassus. A genus of Palm-trees, belonging to the series usually called Fan Palms because their gigantic leaves are formed of plates radiating from the top of the petiole, and folded up after the manner of a fan. *Borassus flabelliformis*, the Palmyra Palm, is an Indian species, with a trunk from thirty to fifty feet

high, and leaves with from seventy to eighty rays. The Hindus consider it the king of trees. An intoxicating liquor, called toddy, or palm wine, is obtained by fermenting its sap, which yields sugar in considerable quantity.

Borate of Lime. [DATHOLITE; HAYESINE; SASSOLIN.]

Borate of Soda or **Borax** (Low Lat.). This salt is composed of 36·58 per cent. of boracic acid, 16·25 soda, and 47·17 water. It is found native in some of the lakes of Thibet and Persia, and is brought to this country from India under the name of Tincal, which after purification becomes the *refined borax* of commerce. Large quantities are, also, made from the boracic acid of the Tuscan lagoons, by combining it with soda. Borax forms variously terminated prismatic crystals, which are slightly efflorescent, and soluble in 18 parts of cold and 6 of boiling water. When heated, water of crystallisation is driven off, and the residue fuses into a transparent mass called *glass of borax*. Borax is chiefly used by workers in metals as a flux, and to aid the process of soldering; it is also employed in medicine, and in the manufacture of glass and artificial gems.

Borates. Salts of boracic acid.

Border or **Bordure** (Icelandic, bord). In Heraldry, according to French heralds, an honourable ordinary, which should occupy a third part of the shield. In English blazonry, it has generally been considered as a mark of difference to distinguish one branch of a family from another. It surrounds the field, is of equal breadth in every part, and occupies one-fifth of the field. When there is a chief on the coat, the bordure is supposed to run under the chief; but it passes over other ordinaries, as a fess, &c.

Bore. A word used to express the sudden rise of the tide in certain estuaries, as in the Severn.

Boreas. In Grecian Mythology, the son of Astræus and Eos, and usually worshipped as the god of the north wind. The assiduity with which the worship of Boreas was cultivated at Athens proceeded from gratitude, the north wind having on one occasion destroyed the fleet of the Persians when meditating the invasion of Attica. A similar cause induced the inhabitants of Megalopolis to consider Boreas as their guardian divinity, in whose honour they instituted an annual festival. Boreas was usually represented with wings dripping with golden dew-drops, and the train of his garment sweeping along the ground.

Boring. The operation of piercing the earth for the purpose of ascertaining the nature of the subjacent strata, or of bringing to the surface any underground springs. A great variety of tools are employed for this purpose, such as augers, jumpers, misers, ball and socket valves, according to the strata traversed. Of these a good description will be found in the work by M. Dégoussée, *Guide du Sondeur*, or in the treatise on *Welldigging* of Weale's series, in which also will be found an account of the arrangements for working the tools at a great depth from the surface, and of the results of some of the most celebrated operations for obtaining a water supply in this manner. The success of the Artesian wells thus found to exist under London, Paris, and Rouen; the great success of the boring at Grenelle, Passy, and at Warren Farm, have indeed been sufficient to justify the favour with which this process is regarded; but unfortunately, the public always hesitate about the preliminary studies necessary to insure such results, so that the invention of well-boring is treated as an empirical study, and one to be left entirely to *practical* men.

Boring has been well applied for the purposes of fixing the posts of electric telegraphs: for the tying down bolts of suspension bridges, and for sinking the tubes now used for the foundations of buildings to be erected in running water, &c.

Boring Worm. The *Teredo navalis* is so called. This is a worm which enters wood in salt water, and there expands until it attains the size of a finger; it bores the wood, into which it enters, during the whole of the passage between high and low water mark, completely riddling it in those parts, and causing an infinite amount of damage to ships, or to piers, docks, and harbours, wherever wood enters the construction in the shape of piles, cills, &c. It is supposed that creosote is the only effective preservative against the ravages of this animal, though a coating of copper nails has been strongly recommended; but there is danger of the animals finding their way into the wood between the small spaces left by the heads of the nails, and then the destruction of the wood is inevitable. Of course great care and attention is required in the application of the creosote (which in the best work is injected after the extraction of the moisture from the wood) under a vacuum, to the extent of 4 lbs. per foot cube; it requires a pressure of about 130 lbs. on the square inch to insure this quantity entering.

It is supposed that the *teredo* only attacks wood when it is exposed on shores able to yield the bicarbonate of lime; at any rate, it is far more destructive in them than in others. The animal also appears to have a distaste for the sewerage waters of towns, perhaps because they are not impregnated with the salts of sea water.

Borneo Camphor. A variety of camphor obtained from the *Dryobalanops Camphora*.

Bornite. A name given (after De Born) to a variety of Telluric Bismuth found at Field's gold-mine in Dahlonga, Georgia, in a quartz-vein, associated with gold and auriferous Iron Pyrites; also at José in Brazil, in marble. It occurs in foliated masses, which have a crystalline structure and split into thin plates, the colour and lustre of which resemble polished steel. The mineral is flexible, sectile, and soils the fingers. The name Bornite has, also, been given by Brooke and Miller to Purple Copper.

Borocalcite. Native borate of lime. [HAYESINE.]

Boron. The base of boracic acid, discovered by Davy in 1807. It may be procured by heating dry boracic acid with potassium. It is a dark olive-coloured substance, a non-conductor of electricity, insoluble in water, infusible, and of a specific gravity = 2. Heated to redness it burns into *boracic acid*, which consists of 11 boron + 24 oxygen.

Borough. A town possessed of certain municipal institutions. The name is derived by some from the Saxon word burg, meaning an enclosed place; by others from another word of the same language—borg, meaning pledge, which was applied to some of the associations for mutual liability established by the Saxon law. Boroughs, in the sense of the definition above given, must, in some shape, have existed very early in this as well as in other countries; but the origin as well in constitution as in name of the existing municipal system in England can be traced no higher than Anglo-Saxon times, and the general and connected history of English boroughs does not begin before the Conquest.

According to Doomsday Book there were in England at that time eighty-two boroughs, including cities, differing considerably in the extent of their franchises as well as in their customs and mode of government; but agreeing in this general character, that they were communities established chiefly for the purposes of trade, endowed to that effect with certain franchises, such as that of a fair or market, and possessing as boroughs a special jurisdiction exercised in the borough court-leet, and exclusive of the jurisdiction of the hundred. Some of them then held, and all were capable of holding, lands in common; and in respect of such land they held, as did also each burgess in respect of his own tenement, of some lord, by a species of tenure called burgage tenure, which was, in fact, similar to the ancient tenure in common socage, i.e. tenure by rent or service certain. This continued to prevail in boroughs after the general imposition upon other lands of the feudal or military service. The lordship of the land of the borough, and of the different tenements which it contained, must have belonged in the first instance to the lord of the manor within which it was situate; but all boroughs, in contemplation of law, held their franchises of the king.

Great obscurity prevails as to what was originally the internal constitution of boroughs, as to how far it was popular or not, and how far also it was or was not uniform. It is certain that as early as the date of Doomsday Book the proportion between the number of burgesses and that of other inhabitants was very different in different boroughs. Much perplexity also arises on this subject from the intermixture in the same place of the guild and borough franchises [GUILD], which prevailed to such an extent that the guild-merchant, which appears to have been an incorporation or an association by license of all trades within the borough, is by some considered as identical in its constitution with the borough itself. It is certain, at any rate, that the guild-merchant, though it did not in the first instance constitute the borough, yet in many places usurped its franchises and government, and finally assumed its name; so that, with the exception of burgage tenure, which still prevailed in some few places, and of birth, which was common to both institutions, the other modes of obtaining the freedom of a borough—i.e. those of apprenticeship, purchase, or gift—were introduced into the municipal system from the guild-merchant. Distinct from this in their relations and contests with the community of the borough at large were the guilds of particular trades, which succeeded in London in engrossing and parcelling among themselves, under the name of liveries, the whole of the municipal franchises.

All borough rights, being exceptive, rested either upon charter, or upon prescription which supposes a charter. Some few of such charters were granted by Saxon kings: but they became much more frequent after the Conquest, the style and purport of these early documents being simply that of a grant to the *men* and *burgesses* of such a place of certain franchises, whether relating to trade, as that of a fair or market or exemption from toll, or to jurisdiction, such as a commission of the peace and the right of holding sessions, which was first granted to any borough by Richard II. In the reign of Henry VI. a remarkable alteration took place in the style of these royal grants, as then first were granted, it is said, charters of incorporation, strictly so called: though previous to that time boroughs, or the governing bodies that represented them, enjoyed all the privileges of a corporation, and since that time many have continued to enjoy them without any such special grant. From that time forth, however, the history of boroughs becomes identical, except as to the parliamentary franchise, with that of municipal corporations. These charters of incorporation did not pretend to regulate the internal constitution of boroughs. This constitution very generally assumed the form of a government by a small and in great measure self-elected body, which in most cases succeeded in engrossing not only the whole administration, and in a great degree the enjoyment of the borough franchises and property, but the right also of granting, according to rules more or less arbitrary, admission into the subordinate body of burgesses or freemen. And even that body, where it existed, which was not always the case, was small in proportion to the whole number of inhabitants. It was the great object of the charters granted by the Tudor sovereigns to sanction and confirm the usurpations of these municipal oligarchies, with the view apparently of throwing the representation of boroughs (a right which, conferred in the first instance by Edward I., had since been extended by fresh grants, and was then becoming of considerable importance) into the hands of such as were most likely to

be easily guided or controlled, either by the crown itself or by the great lords upon whose support it reckoned. The latter began about the same time to connect themselves with the boroughs, in the neighbourhood of their possessions, under the honorary title of high stewards. The exclusive system of municipal government, which attained its height during the Stuart dynasty, continued unimpaired until it was effectually put an end to by the Act for the Regulation of Municipal Corporations, passed in the year 1835. For an account of this change, as well as of the other remarkable incidents in the history of our municipal institutions, which have happened from the time of the Tudors to the present period, see CORPORATIONS; and for an account of the *representation* of boroughs, and particularly of the *reform* in *their representation*, see PARLIAMENT.

The account above given of English boroughs, both as to their origin and constitution, applies in all its general features to Scotch boroughs; with this qualification, that the government by close corporations was in Scotland more thoroughly and more generally prevalent until the reform in them. This was effected by law preceding by a year the Municipal Corporation Act applicable to this country, and resembling the latter in almost everything but this, that it made the qualification for burgess-ship identical with that required to give a vote in the election of members, namely, the occupancy of a house of the yearly value of 10*l*.

In Ireland the municipal system, as it now exists, is of considerably later origin than in Scotland or in England. It was transplanted, and gradually introduced from the latter country; and though with the same names and form of constitution as then existed there, had much more in it of a political character, being intended in the first instance as a support to the English against the Irish, and in later times to the Protestant against the Catholic, and was so used to the neglect of functions more properly municipal, which have therefore in many instances been intrusted to other hands by local Acts of Parliament.

Borough, English. In Law, is a customary mode of descent of lands in some ancient boroughs and manors, by which estates descend to the owner's youngest son; or if he has no issue, to his younger brother. [DESCENT.]

Bos (Lat.). A genus of hollow-horned Ruminants which is found extensively distributed over the Old World. Five species are known to zoologists. The *Bos Taurus* is well known as our domestic ox, many varieties of which have been produced by domestication. With respect to the wild original of our numerous herds there is yet some obscurity; less, however, than hangs over the origin of some other domesticated species. The wild cattle which approach nearest to the tame are those which inhabit the forests of the north-east of Europe, and the white cattle, which are still preserved in a state of purtiy at Craven, at Chillingham Park, and in Scotland. These are both referred to the species called *Bos Taurus*, or *Bos Urus*, or *Urus scoticus*; but there is much reason for supposing this species to have been the domestic ox reverted to a state of nature. Another well-marked variety of this species is the Brahminy bull, characterised by the hump on the shoulders and the hanging dewlap (*Bos indicus*).

The other known wild species of ox are the Gayal of India (*Bos gavæus*); the Yak of the mountains of Central Asia (*Bos grunniens*); lastly, there are the Buffaloes, which, though anatomically less distinct than the Bisons from the typical *Boves*, yet differ from the oxen as a group in many points. They have larger horns, which sometimes form a horny covering of great thickness to the whole frontal region; and they approach the Pachydermata in the thickness of the skin and the thinly scattered coarse hair. They frequent marshy grounds, and feed on a ranker herbage than the ox. The flesh of buffaloes is coarse, and they are used chiefly as beasts of draught or burden. The two best marked species are the Indian or Arnee buffalo (*Bos arnee*), and the South African buffalo (*Bos caffer*).

Bosjesman (Dutch, *man of the wood*, or *bushman*). A name given by the Dutch colonists to some roaming tribes akin to the Hottentot, in the vicinity of the Cape of Good Hope. The description given by Governor Janssens of this people represents them as so deeply sunk in barbarism as to be unacquainted even with the construction of huts or tents. They are of a dark copper complexion, small in stature, and of a singularly malicious, wild, and intractable disposition.

Boss (Fr. bosse). A term applied in mediæval Architecture to the piece of stone, usually carved in a fanciful manner, which covers the intersection of a series of arches. It is commonly finished with a flower, or a human masque, and is one of the most characteristic specimens of mediæval decoration.

Bossage (Fr.). In Architecture, any projection left unwrought on the surface of a stone for the purpose of afterwards receiving a sculptural decoration, which is generally the last part of the work executed.

Bostrichus (Gr. *βόστρυχος*). A genus of Coleopterous, Xylophagous, or wood-boring insects, now raised to the rank of a family (*Bostrichidæ*), including amongst its numerous genera three which contain species whose ravages have called forth the attention of the legislature both in this and other countries in consequence of the extensive destruction of valuable timber caused thereby. The species in question are the *Bostrichus ligniperda*, *Scolytus destructor*, and *Tomicus typographus*; but the two latter are the most mischievous, and astonish us by the amount of damage produced by insects of so small a size. The elm-tree is the object of attack to the *S. destructor*; while the *T. typographus* restricts its operations to the fir. The females attack the crevices of the bark,

and perforate it in diverging lateral channels, in which from sixty to eighty eggs are deposited. At the end of fifteen days the larvæ are hatched, and forthwith commence the work of destruction, each gnawing a serpentine gallery between the bark and the wood, and gradually enlarging its burrow until the period when it is ready to pass into the pupa state, when, having finally become a perfect beetle, it directly bores through the portion of the tree which remains between the wood and the outer bark, and escapes through a small circular aperture in the latter. This emergence of the perfect insect takes place in the month of May; and in seasons favourable to their developement they appear in swarms, and rise to a height exceeding that of the trees, and may be carried by the wind to another and distant part of the forest. The impregnation of the female takes place in the air; so that wherever they alight they are ready to recommence the work of destruction. The chief precautions and remedies which experience has suggested are to cut down the trees which are once attacked, immediately to bark them and to burn the bark, and to remove all felled timber without delay.

Boswellia (named after Dr. Boswell of Edinburgh). A genus of Indian trees belonging to the natural order *Amyridaceæ*, one species of which, *B. thurifera*, yields the resin called Olibanum, which seems to be a corruption of Luban, the name given by the Hindus to this plant.

Bot. The name of the larvæ of the Dipterous insect of the family *Œstridæ* [which see].

Botanic Garden. A garden devoted to the culture of a collection of plants, with reference to the science of botany. The legitimate object of gardens of this description appears to be to collect and cultivate, at the public expense, all the species and varieties of plants that can be cultivated in the given climate, with or without the aid of glass; and then to distribute these to private individuals throughout the district by which the botanic garden is supported. The most complete system of this kind ever established appears to have been that of France soon after the Revolution. All the botanical articles that could be procured from other countries were sent to the botanic garden at Paris; and after they had borne seeds or been propagated there, the progeny was distributed among the provincial botanic gardens, of which there is one or more in every department. After being propagated in the provincial botanic gardens, the seeds or progeny were given out, free of expense, to all who in the district to which the garden belonged thought fit to apply for them. As the useful species and varieties were not less attended to than those which were cultivated only in a scientific point of view, the greatest facilities were thus given to the spread of every useful grain, pulse, culinary vegetable, and fruit, over the whole of France.

Botany (Gr. βοτάνη, *herb* or *grass*). That branch of natural history which relates to the vegetable kingdom; not merely including the nomenclature and classification of plants, as some have supposed, but embracing all the phenomena of vegetable life in their widest extent.

One of the most important departments of Botany is that called *Organography, or the Structure* (*Organisation*) *of Plants.* This comprehends whatever relates to the various forms of tissue of which plants are anatomically constructed; it explains the exact organisation of all those parts through which the vital functions are performed; and it also teaches the relation that one part bears to another, with the dependence of the whole upon the common system. Without a perfect knowledge of Organography no systematical arrangement can be understood; for, being that part of science in which the laws of the symmetry of parts are comprehended, it must necessarily be the basis of all theory of classifications: nor can Descriptive Botany, which may be called the language of the science, have any logical precision, or be intelligible, unless the mind is distinctly impressed with the fundamental laws of this branch of study. Physiology itself, the highest branch of all natural science, depends so absolutely upon an exact knowledge of the structure of parts, that any attempt to investigate the important laws of vegetable life must necessarily be abortive without a strict acquaintance with the more important details of organisation. And by this is not meant merely a general idea of external form, or a vague notion of internal anatomy, but the most precise knowledge that the nature of the subject will admit.

Connected with this branch of study is what German botanists call *Morphology*. The word Morphology signifies literally the 'science of changes or transformations.' As applied to botany, it embraces a subject of enquiry which, to all those who know the importance that attaches to comparative anatomy in the animal kingdom, cannot fail to be peculiarly interesting. It has been clearly made out that all those parts which are familiarly known under the name of leaves, flowers, and fruit, are constructed, in all cases whatsoever, upon a simple uniform plan, out of one single organ in different states of modification and combination; and that there is no other difference between the flower of a rose and that of a nettle than what arises from modifications and combinations of this origin—which is the leaf. If it be doubted whether, considering the anomalous character of some of the lower orders of plants, all vegetables are without exception formed upon one and the same plan, it is impossible not to admit that, at least in all Phænogamous plants, the flowers are composed of the same elements; that these elements are arranged in conformity to a few simple laws (far less variable than their appearance seems to indicate), and the study of which constitutes the basis of the theory of botany. These laws are so evident in a great number of cases, that we

scarcely pay attention to them; but curiosity is at once excited when they seem to be violated. Exact observation, however, shows that in such cases they are only masked; that is to say, an unusual application of two or three different laws produces an apparent anomaly, which is easily explained by a reference to the numerous cases of degeneracy, abortion, and cohesion with which the vegetable kingdom abounds. In such instances as this the botanist may be compared to the mineralogist, who discovers the primitive forms of crystals by means of their secondary forms. We are so accustomed to talk of plants bearing leaves and flowers and fruit, and it is so evident to our senses that extremely different organs really do exist under such names, that it seems inconceivable that parts so very dissimilar should all be only leaves in different states; or that the pure white petals of the lily, the rich red flowers of the rose, the sweet-smelling blossoms of the jasmine and the orange, or the long trumpet-shaped corollas of the honeysuckle, should all be leaves; or that the stamens in which the fertilising powder is locked up, the pistils which are destined to receive the influence of the pollen, the ovules that they contain, and finally, the fruit which is the result of the action of the two last, are all so many parts formed out of one common organ, which in a very particular and frequent state is what we call a leaf. Botanists do not mean to say that he who eats an apple, or an orange, or a peach is in a state of mental delusion, and that while he fancies himself to be enjoying the pleasure of gratifying his palate by the most delicious flavours he is really only chewing the leaves of these plants; but they assert that those appendages of a plant which are commonly called the leaves have a peculiar anatomical structure, and a certain relation to the stem on which they are borne, and being developed according to certain fixed laws, are always arranged upon a certain and uniform plan with respect to each other; and that all the other organs, whether calyx, corolla, stamens, pistils, or fruit, have an anatomical structure essentially the same, bear the same relation to the axis that they grow upon, are developed according to the same laws, are arranged upon the same certain and uniform plan with respect to each other, and, finally, are constantly becoming transformed into leaves of the ordinary appearance, thus losing the condition in which they are usually found, and reverting to their structural type. The admission of such propositions as these does not render our notions of the distinctions between the various organs more obscure than it was before, as some would assert; but on the contrary it enables us the better to understand the real nature of the organisation of any part, and the plan upon which the most complicated arrangement of these organs has been effected. For example, who is to explain how it happens that buds occasionally spring from the axils of petals or sepals, that anthers are found bearing ovules, that branches push forth from the centre of pistils, that petals become antheriferous and stamens petaloid, unless the proposition is admitted that all those apparently different parts are formed upon a common plan, the type of which is a leaf, and are all therefore convertible into each other?

Another leading branch of the science is *Physiology*, or the department which treats of the vital actions of plants. While Organography is applicable to objects whether living or dead, Physiology solely refers to them in a state of vitality. There is scarcely any part of natural history more difficult than this, if rigorous demonstration is required, nor, at the same time, one upon which there was in former days a greater degree of mere speculation. Like many other of the higher departments of natural philosophy, hypothesis preceded experiment; so that in the earlier history of botany we find scarcely a trace of those ideas which modern observation has developed in a very remarkable manner.

It was not till after the invention of the microscope that even an imperfect knowledge of vegetable anatomy could be gained; and only when this great step was taken, vegetable physiology began to establish itself upon a sure foundation. Consequent upon this discovery has been the accumulation of a considerable amount of positive knowledge of a world of organised beings having nothing in common with the race of man, and with which we cannot communicate in the slightest degree; that have no volition by which we may occasionally regulate our judgment; whose texture is so frail that we cannot anatomise them without the destruction of life; whose functions are performed within an opaque dense covering that excludes everything from our view; and which finally are so exceedingly simple in their organisation, and have so few different organs with which to execute their functions, that we are lost in amazement at effects so complicated and forms so various being brought about by means that are seemingly so inadequate. The world has learned from the vegetable physiologist, not only that plants breathe, feed and digest, and how the functions of breathing, feeding, and digesting are carried on; they have also ascertained by what means an increase in their dimensions is brought about, how their want of locomotive power is compensated, and by what precise means their reproduction and multiplication are so wisely ordained as to be placed beyond obstruction by any natural impediments. In short, the exact use of every part of every plant, various as their forms and uses doubtless are, has been ascertained; and we are now entitled to say of plants as of animals, that their kingdom is rendered subject to the power not only of man's physical energy, but of his mental resources.

Perhaps no part of the creation illustrates more forcibly than the vegetable world, the admirable skill and foresight with which all the phenomena of the universe have been adapted by the Great Author of our being to the accomplishment of the objects for which they have

been severally intended. Take, for example, vegetable tissues. What can be conceived more wisely prepared! The cellular tissue, capable of indefinite extension, possessing also prodigious compressibility, its particles cohering either firmly or loosely according to circumstances, its sides composed of a most delicate membrane, through which fluid and gaseous matter passes readily in every direction, is destined to form the principal mass of the vegetable, and to execute all those functions with which absorption and respiration are connected. The fibrous tissue, composed of myriads of threads compactly combined into bundles, dispersed through the cellular substance, admirably supplies the place of bones and nerves in the animal economy, affording strength, solidity, and elasticity to the most delicate parts; while the vascular tissue, exclusively intended for the reception and rapid transmission of gaseous and liquid matter from the roots to the extremities, is most wisely contrived, and most carefully prepared by its spiral structure, for extending and turning, as the cellular substance developes, to those parts where the peculiar matter that it contains is most required. Here there is no confusion of offices; each part has its peculiar function assigned to it, for which it has been especially destined and for which it is alone adapted.

Then look at the leaves. The leaves are the organs in plants that correspond with the stomach in animals; that is to say, it is in them that the fluid matter taken up by the roots, and injected into them from the stem, is digested and inspissated, and separated into the nutritious and excremental portions.

Digestion takes place in leaves chiefly by the absorption of carbonic acid, the emission of oxygen, and the evaporation of water. If this process were to be carried on without any provision against the variations which are constantly occurring in the state of the atmosphere, it is easy to conceive that in excessively dry weather leaves would lose all their moisture and constantly become parched up, while in wet weather they would be so gorged with moisture as to burst from distension. In order to prevent the occurrence of this, Nature has enclosed leaves in a cuticle scarcely pervious either to air or moisture; and in this cuticle she has placed numerous mouths, called stomates, which have the power of opening and closing, according to the state of either the atmosphere or of the leaf itself, to regulate the absorption or respiration of either water or air. And in order to expose the tissue lying beneath this cuticle to the greatest possible atmospheric influence, the leaf is not a solid mass, as it appears to be, but is traversed in all directions by passages terminating in the mouths and opening into cavities, where the air both of absorption and exhalation can freely circulate and pass in or out so long as the mouths permit it. Nor is this all. Many leaves are constantly submerged beneath the surface of water, where they are never exposed to atmospheric vicissitudes, can never evaporate, and being cut off from the air, can neither absorb carbonic acid from the air, nor discharge oxygen back into it in return. It is therefore obvious that the curious provision that has been made for the regulation of the action of aërial leaves would be useless in submersed ones; and accordingly we find that the latter have neither cuticle, nor mouths, nor cavernous parenchyma, and are thin but solid plates, the whole surface of whose cellular substance is in direct contact with the water, from the air contained in which the leaves must exclusively derive their nutriment.

The employment of the same kind of organ, in different forms, for the purpose of effecting the varied objects that are to be provided for in the vegetable economy, is another and a most remarkable instance of the consummate wisdom and wonderful simplicity discoverable in all these things. Upon the birth of a plant one or two leaves are developed, which feed the infant until it is strong enough to develope one or two more. These last not only, like the first, proceed without exception from opposite sides of the stem or body, but are so placed as to alternate with the first. This goes on with unvarying uniformity, as long as growth continues; so that, view a plant in whatever way we will, whether in its earliest state, or at the most advanced period of its existence, it will always be seen to exhibit the same beautiful symmetry as the most highly developed animals. One side counterpoises the other; whatever is discoverable on one side, equally exists upon the other. If it is necessary that a protection should be formed for securing the young and tender buds against cold, the leaves surrounding the buds suddenly contract into hard scales, perhaps exude some resinous or gummy matter, or clothe themselves in a deep covering of wool, and an impenetrable living shield is thus interposed between the bud and danger. If a plant is to be rendered more beautiful to the eye, its leaves again contract, the spaces that usually separate them are obliterated, new colours are assumed, and petals are created resplendent with brilliant hues or exhaling the softest perfumes. If propagation is to be effected, the petals contract into stamens, their central substance becomes disintegrated in the form of pollen, and the interior of each grain of the latter is resolved into that living matter of which in a state of cohesion all nature is composed. A few leaves are rolled together in the form of pistil, the apex of the midrib becomes denuded, and young buds are developed at the margins. A grain of pollen, the disintegrated tissue of the flowering leaf, falls upon the denuded apex of the fructifying leaf, absorbs moisture from it, distends, and finally produces a tube of inconceivable fineness, which abstracts from the pollen its impregnating matter, some of which descends the midrib into the womb of the leaf, and thence entering the young buds that are developed at its margins, is finally hatched, and appears at last in the form of embryo plants. Such is the simplicity

of the arrangements that are observable in the most perfectly formed, the most elaborately constructed plants. In the lower orders, the mode of formation, developement, and propagation is still more simple. A vesicle elongates and distends until it becomes a tube; from the end of this tube more vesicles are generated which themselves give birth to others, and thus a simple branching plant is formed. In the inside of each tube by degrees a green matter is deposited; and after a certain period has elapsed, it is emitted in the form of little green vesicles, like that from which the plant originally sprang, and themselves capable of developing as new plants. In certain tubes, this dissolution takes place in a much more astonishing manner; not into inert green matter, but into moving particles, having all the properties of spontaneous motion and animal existence. Soon, however, the moving particles elongate: thus losing their power of motion and becoming plants, to whose laws of life they ever after submit.

These are far from being all the divisions into which Botany, or the study of the vegetable kingdom, may be subdivided; although they are no doubt among the most interesting. Besides these there is *Taxonomy, or the Principles of Classification*. It would be of little use that a man should know anatomy, and structure, and comparative organisation, and have informed himself of all the leading principles of physiology, if he were unacquainted with the names of the objects he had been studying, and were consequently incapable of communicating his knowledge to others. At least, of whatever use it might be to himself, it could not be of advantage to anyone else. But if he *is* acquainted with the names of known objects, and if he understands the rules of classification, he can then render his information available to others as well as to himself. And in like manner he can at all times determine what is known about any particular plant that he may have been studying; or if it be a kind previously unknown, he can find its place in the system, and by publishing a description of it, he can fix it there for the information of others.

But there is another way of looking at the utility of classification, which shows that what may to some appear but a dry and barren subject, is in reality one of the most important branches of the science. No man can know all things relating to such a science as this—few men can learn many things; for this reason it is of importance that a means should be discovered of judging of what is unknown by what is known; and that by judiciously selecting a moderate number of objects for particular study, the enquirer may have a ready and in no way burdensome means of forming a clear knowledge of the whole vegetable kingdom. This is not difficult, if attention be paid to the doctrine of affinities. Everyone must have seen that some species of plants are more like each other than they are like different species. Without considering the matter botanically, everyone must, for example, have remarked that a radish is more like a turnip than it is like a currant bush, that a pea is more like a bean than an apple, and that a cherry blossom is more like an apple blossom than a horse-chestnut. These are rude instances of affinity on the one hand, and discrepancy on the other; but they are nevertheless perfectly explanatory of what is meant. Botanists find that classification may be founded upon a consideration of general resemblances and differences; and that by carefully examining the characteristic organs of plants, those species may be classed most nearly together which have the greatest degree of resemblance and the most perfect constitutional agreement. Now, this being the case, it follows that a knowledge of one species is to a great extent a knowledge of many; and that a correct idea of a single individual of a group in the classification, provided that individual is well selected, involves to a considerable extent a knowledge of all the other species of the same group. For example, in the *Cruciferæ*, consisting of perhaps 1,600 species, the study of the common radish, the mustard, or the cress, will give the student a very accurate general knowledge of the remaining number, because they are all close modifications of the same forms. Again, the common potato, rightly understood, represents the greater part of *Solanaceæ*, or at least of some hundred species belonging to that tribe; while the dead-nettle, *Lamium album* or *rubrum*, stands as the representative of some 2,000 or more species called *Labiatæ*. This would be of eminent importance if its advantage stopped here; but when it is considered that the properties of plants also accord in a very remarkable manner with their structure, and that those which are most closely approximated in a classification will most nearly resemble one another in their sensible properties, the advantages to be derived from a study of the laws of affinity cannot fail to be clearly perceived. For example, to use the same illustrations as before, anyone acquainted with *Cruciferæ* would know that there is no instance of a poisonous or deleterious plant in the tribe, a point of great importance to be aware of: on the contrary, he would know that if they had succulent roots, they might be employed like the radish, and that their leaves were antiscorbutic: but if he met with an unknown plant, which, from its resemblance to the potato, he knew belonged to *Solanaceæ*, he would at once reject it as poisonous, or at least suspicious, unless it had tubers filled with fæcula, when he would except that portion, because all fæcula is wholesome, however poisonous the trees or plants may otherwise be that produce it, provided the deleterious matter that lies among it is removed by washing or volatilised by the action of heat.

It is not, however, any kind of classification that leads to such ends. All artificial systems, as for instance that of Linnæus, are unproductive of such results. It is only the Natural

System of botany from which these important advantages are to be derived.

Another division of the science relates to the meaning of the terms employed; this was formerly called *Terminology*, but now more correctly *Glossology*. It is the least interesting part of the subject; but at the same time it is too important to be passed over lightly, because it is impossible either to understand the writings of botanists, or to make oneself intelligible to others, without being correctly informed of the meaning of the terms peculiar to the science. The state of Terminology at any given time may indeed be safely taken as indicative of the state of the whole science; for in proportion as ideas are multiplied and knowledge rendered exact, the more are the terms required to express those ideas multiplied and their application rendered definite. A curious exemplification of this is to be found in the *Historia Plantarum* of Fuchs, a learned botanist of the sixteenth century. In the glossary prefixed to that work are comprehended only 132 terms of all kinds, many of which refer to measures, and are therefore not appertaining to botany; and of the remainder, 29 belong to modifications of stems, 15 to differences of inflorescence, 6 to the fruit, but not one to any other part of the fructification. In the present state of botany, the terms that relate to the seed alone are probably as numerous as the whole of those comprehended in Fuchs's Glossology.

Another and very distinct branch of botany is that which concerns the rules to be observed in describing and naming plants; or what is called *Phytography*. The great object of descriptions in natural history is to enable any person to recognise a known species, after its station has been discovered by classification, and also to put those who may not have had the opportunity of examining a plant themselves, into possession of all the facts necessary to acquire a just notion of its structure and affinities. It is therefore important that such descriptions should be drawn up according to certain conventional well-known rules, and not according to the caprice of individuals; and this not only for the sake of insuring uniformity of language, and in all cases the same order of treating the subject, but also to prevent descriptions being too general, to fix attention on the most important points of structure, and at the same time to prevent their being more prolix than is really necessary. The rules of description are more especially intended to guard against the latter evil; for no mistake can be more common than to confound prolixity with precision.

The last branch into which the study of the science may be divided, is the application of the preceding subjects to the art of discriminating species. This may be called the *Practice of Botany*, as the former belonged to its theory, and is by far the most difficult part of the subject. There is no difficulty in becoming acquainted with the fundamental principles of the science, because they naturally arise out of each other, and are dependent upon the just appreciation of a few simple laws, the various combinations of which, upon principles easily comprehended, constitute the differences that exist between organs themselves and their numerous modifications. But the practice of botany, although its study is essentially facilitated by an acquaintance with fundamental principles, and indeed cannot be usefully pursued without it, yet has peculiar difficulties of its own. It is often difficult to recognise organs in consequence of the manner in which they are masked by the modifications they have undergone; their combinations are frequently so intricate that great experience is necessary to enable an observer to judge of them correctly; their minuteness is often such as to render indispensable a use of the microscope, which requires peculiar dexterity and a good deal of practice; and finally the number of species is so great, that to bear in mind their distinctions is a heavy tax upon the memory. Difficulties of this nature are almost insurmountable by a student who is unaided by the experience of a teacher.

At what period of the world botany first began to be studied as a science, has not been satisfactorily ascertained. That in the most remote ages man had his herbs and his roots; that he was acquainted with the properties of one plant, and the uses of another; that he gave them names, and that poets derived many beautiful thoughts from them, was natural enough; but this had nothing to do with botany. The first dawn of that science broke from out of the deep investigations of the nature of matter and mind by the philosophers of Greece. How much they knew, we have no accurate means of judging; but that they knew a great deal of vegetable physiology is obvious from their famous paradox, that plants are only inverted animals — a sentiment which, however strangely it may sound, could only have arisen from an extensive knowledge of the vital phenomena of Vegetation. Nor could the doctrine of Aristotle, that all organic matter exhibits a series of successive degrees of developement, have been conceived or promulgated, unless the philosophers of his day had possessed a practical acquaintance with vegetation much beyond that of the ages that succeeded.

Happy had it been for those ages if, instead of retrograding in the path of science, or rather stepping out of it altogether, they had only pursued the course commenced by Theophrastus 350 years before Christ. By that naturalist the beginning was made of applying particular terms to particular modifications of structure. He demonstrated the absence of all philosophical distinction between trees, shrubs, and herbs— a distinction upon which his successors were fond of insisting; he speaks clearly of the parenchyma and woody fibre of wood, the former of which he calls the flesh; and he described accurately the difference between palm wood and that of trees with concentric layers; so that in point of fact the discovery of the difference

between Dicotyledonous and Monocotyledonous wood was made by Theophrastus above 2,000 years ago, although it was never applied to the purposes of systematic division till our own time. Subsequently to this period, botanists almost disappeared for a long season. Those who have been dignified by historians with that title were either pharmacologists, like Dioscorides; or compilers, who, like Pliny, knew little themselves, and misunderstood those whom they copied; or poets, who drew much of the beauty of their language from the charms of nature; or geoponical writers, who were acquainted with those parts of husbandry which relate to physiological botany.

With whom the curious arts of budding and grafting, and striking plants by layers, or propagating them by taking advantage of the divisibility which distinguishes the vegetable from the animal kingdoms, originated, is now unknown; but there is reason to believe that the greater part of the modifications of those processes was in the classical ages as well understood as now. That grafting was extensively undertaken, is obvious from the lines of Virgil:

Et sæpe alterius ramos impunè videmus
Vertere in alterius, mutatamque insita mala
Ferre pyrum, et prunis lapidosa rubescere corna.

But, what is much more curious, the delicate process of budding was as scientifically performed at that period as by the most skilful gardener of the present century. Nothing can be more precise than the following elegant description of Roman budding:—

Nec modus inserere, atque oculos imponere simplex.
Nam qua se medio trudunt de cortice gemmæ
Et tenues rumpunt tunicas, angustus in ipso
Fit nodo sinus; huc aliena ex arbore germen
Includunt, udoque docent inolescere libro.

Again, of crown grafting:—

Aut rursum enodes trunci resecantur, et alte
Finditur in solidum cuneis via: deinde feraces
Plantæ immittuntur: nec longum tempus et ingens
Exiit ad cœlum ramis felicibus arbos,
Miraturque novas frondes et non sua poma.

From the time of Theophrastus all philosophical enquiry into the nature of vegetation ceased for about 1,700 years, during the whole of which time scarcely a single addition was made to the stock of knowledge left by that writer. But with the revival of letters a new direction was given to researches in natural history. Men ceased to content themselves with blindly copying the writers of antiquity, and set themselves in earnest to examine the objects of nature that surrounded them. The woods, the plains, the rivers, the ocean, the valleys, and the mountains, were investigated with an ardour that soon made amends for ancient indifference. The first consequence of this was a discovery of the worthlessness of the greater part of those writers to whom the world had so long been bound in servile obedience. The spirit of enquiry once excited, men speedily learned to estimate rightly the greater value of facts than of assertions; one discovery produced another, and in a few years a new foundation was laid of that imperfect but beautiful science which constitutes modern botany.

Up to the middle of the seventeenth century, vegetable physiology had been grounded upon observations entirely independent of anatomical investigation. But about this time the accurate enquiries of two naturalists, one an Englishman and the other an Italian, gave a new feature to the study; and what was vague or imaginary in the opinions entertained upon the vital functions of vegetables gave way to conclusions, precise and supported upon the firm basis of careful observation. The nature of cellular tissue, of spiral vessels, of ducts, of woody tissue—the composition of the internal parts of plants, and the functions of the whole—excited enquiry, and received reasonable if not accurate explanations. Collections of facts and of ideas accumulated on all hands, and the confusion that had once been caused by ignorance threatened again to overwhelm the science, in consequence of the rapid addition of new matter which there was no means of keeping in order. Hence systematists sprung up—a race of enquirers to whose labours the present advanced state of botany is no doubt much to be ascribed. That the efforts of the earliest of these writers should have proved unsuccessful, will excite no surprise. With little knowledge of vegetable physiology or anatomy—for it must not be forgotten that for a long time, and even now, vegetable physiology and systematic botany were considered as distinct sciences, and with scarcely any notion of the laws of affinity and metamorphosis—they could not be expected to succeed. We should rather wonder at what they did, than at what they omitted to do. Many of them had great merit, especially John Ray, an English deprived clergyman, and Joseph Pitton de Tournefort, a professor of botany at Paris, who flourished in the latter part of the seventeenth century, and upon whose systems the modern arrangement according to natural orders is essentially founded. This, however, with all others, was for a time eclipsed by another, better adapted to the circumstances of the times, and emanating from a writer who, having the courage and talent to carry reformation into every branch of natural history, imparted a lustre to his peculiar system of classification which has only now, after the lapse of a century, fallen into disuse among men of science.

Charles Linné, or Linnæus, as he is usually called, was a person exactly adapted to the science of the time in which he lived. The various departments of natural history had not at that time anything like their present extensive range, and might without difficulty be investigated by a single naturalist. They were all equally in need of revision and improvement; they all wanted a settled code of laws to reconcile the fluctuating and jarring opinions which at that time prevailed, and above all things the nomenclature of natural history required to be reduced to one uniform standard. For this Linnæus was peculiarly well adapted. Nature had gifted him with a logical accuracy

of reasoning, and a neatness and perspicuity of expression, which carried with them a charm that the world was not slow to appreciate; and these produced the stronger impression, because naturalists had previously been but little accustomed to them. Thus the opinions of Linnæus were received as if oracular, their faults being lost sight of in the splendour which they threw over the whole of the organic world; and he not only established his famous method of arrangement, which for a long time superseded all others, but laid the foundation of the curious laws of morphology, upon which modern botany founds one of its greatest claims to perfection. The notion faintly shadowed forth by Linnæus in his *Species Plantarum*, that all the parts of plants are mere modifications of leaves, became the subject of a special and most original dissertation by the German poet Goethe, in 1790; and though this doctrine was believed by the botanists of that day to be worthy only of the poetical fame of its illustrious author, it is now received, with little change, by every botanist of reputation.

After the artificial system of Linnæus, followed the natural system of Jussieu. Vegetable anatomy became an important branch of enquiry; the researches of Knight and others gave a new character to vegetable physiology; and the early part of the present century saw the science assume an entirely new appearance. Our knowledge of the vital functions of plants reposes upon the sure basis of exact observation and careful experiments; the theory of the plan upon which the organs of vegetation and fructification are severally combined into so many numerous forms is settled upon the clearest evidence; and classifications, to a great degree freed from the trammels of prejudice, have assumed that position in science to which their importance, when rightly studied, entitles them.

The only two botanical arrangements now in use are the Linnæan and the Natural. The former is an attempt at classifying plants according to their agreement in some single characters, without reference to their resemblances or differences in any other respect, just as words are arranged in a dictionary by the accordance of their initial letters. The other is a scheme for placing next each other all those plants which have the greatest resemblance, and at the greatest distance those which are most dissimilar. The distinctions derived from great physiological peculiarities are considered fundamental, and form classes; while characters, derived from diversities of external structure, are subordinate, and valued according to their permanence or frequency, &c. The final result is the making up of the vegetable kingdom into associations, called Natural Orders, which are supposed to consist of genera more closely allied to each other than to anything else. For an explanation of the details of the Linnæan method of classification, the reader is referred to the works of Willdenow and others of that period; and for those of the Natural method to the writings of Jussieu, Decandolle, and Lindley.

The Classes in the Sexual System of Linnæus, now all but exploded, depend upon the number and relative position or degree of combination of the stamens and styles. The characters of the orders, or minor groups, depend upon the number of the styles, or of the stigmas if there be no style; upon the nature of the ovary; upon the form of the fruit; upon the arrangement of the flowers, the sex of their florets, &c.

The Natural System of Botany, formed by Jussieu out of the views of Ray, Tournefort, and others, in combination with very numerous observations of his own, is the basis of what is at present understood by that name. It has, however, been much modified by succeeding systematists. The more important methods which have been promulgated, agree in adopting as their basis the fundamental divisions of Phanerogamous Vascular or Flowering, and Cryptogamous Cellular or Flowerless plants; the former being again separated into Dicotyledons the equivalents of Exogens, and Monocotyledons the equivalents of Endogens. A very full account of the various schemes which have been proposed, will be found in the introductory portion of Lindley's *Vegetable Kingdom*, to which we may refer for details.

The arrangement of De Candolle is that most commonly in use, having been familiarised by the *Prodromus* of that author, a most important book of reference for all working botanists. This arrangement includes 219 orders, under the primary divisions of Vasculares and Cellulares:—

Vasculares or *Cotyledoneæ* are plants furnished with cellular tissue and vessels, and whose embryo is provided with one or more cotyledons. This includes the *Exogenæ*, or *Dicotyledoneæ*, in which the vessels are arranged in concentric layers, the youngest ones being the outermost, and the embryo is furnished with opposite or verticillate cotyledons; and the *Endogenæ*, or *Monocotyledoneæ*, in which the vessels are arranged in bundles, the youngest ones being in the middle of the trunk, and the embryo furnished with solitary or alternate cotyledons. The Exogens are divided into the *Dichlamydeæ* with a double perianth, that is, the calyx and corolla distinct; and the *Monochlamydeæ* with a simple perianth, that is, the calyx and corolla form only one envelope. The Dichlamyds are again divided into the *Thalamifloræ*, in which the petals are distinct, inserted on the receptacle; the *Calycifloræ*, in which the petals are free or more or less united, always perigynous or inserted on the calyx; and the *Corollifloræ*, in which the petals are united into a hypogynous corolla, or not attached to the calyx.

Cellulares or *Acotyledoneæ* are plants composed of cellular tissue only, not furnished with vessels, and whose embryo is without cotyledons. This includes the *Foliaceæ*, consisting of plants which have leaf-like expansions, and known sexes; and the *Aphyllæ*, consisting of plauts

which have neither leaf-like expansions nor (as was then supposed) known sexes.

In the arrangement proposed by Lindley the number of Orders extends to 303. The main divisions consist of *Asexual* or *Flowerless plants*, which include Thallogens and Acrogens; and *Sexual* or *Flowering plants*, which include Rhizogens, Endogens, Dictyogens, Gymnogens, and Exogens.

THALLOGENS are Flowerless plants whose stems and leaves are undistinguishable. They include the following Alliances:—

Algales.—Cellular flowerless plants, nourished through their whole surface by the medium in which they vegetate; living in water or very damp places; propagated by zoospores, coloured spores, or tetraspores. Ex. *Fucaceæ*, or Seaweeds.

Fungales.—Cellular flowerless plants, nourished through their thallus (spawn or mycelium); living in air; propagated by spores, colourless or brown, and sometimes enclosed in asci; destitute of green gonidia. Ex. *Hymenomycetes*, or Toadstools.

Lichenales.—Cellular flowerless plants, nourished through their whole surface by the medium in which they vegetate; living in air; propagated by spores usually enclosed in asci; and always having green gonidia in their thallus. Ex. *Parmeliaceæ*, or Leaf Lichens.

ACROGENS are Flowerless plants whose stems and leaves are distinguishable. The Alliances are—

Muscales.—Cellular (or vascular); spore-cases immersed or calyptrate (i. e. either plunged in the substance of the frond, or enclosed within a hood). Ex. *Bryaceæ*, or Urn Mosses.

Lycopodales.—Vascular; spore-cases axillary or radical, one or many celled; spores of two sorts. Ex. *Lycopodiaceæ*, or Club Mosses.

Filicales.—Vascular; spore-cases marginal or dorsal, one-celled, usually surrounded by an elastic ring; spores of but one sort. Ex. *Polypodiaceæ*, or Ferns.

RHIZOGENS are Flowering plants with fructification springing from a thallus. The Orders are *Balanophoraceæ*, *Cytinaceæ*, and *Rafflesiaceæ*.

ENDOGENS are Flowering plants with fructifications springing from a stem; the wood of the stem youngest in the centre; the cotyledon single; and the leaves parallel-veined, permanent. The Alliances are:—

Glumales.—Flowers glumaceous, that is to say, composed of bracts not collected in true whorls, but consisting of imbricated, colourless, or herbaceous scales. Ex. *Graminaceæ*, or Grasses.

Arales.—Flowers naked, or consisting of scales, diclinous, two or three together, or numerous and then sessile on a simple naked spadix; embryo axile; albumen mealy or fleshy, sometimes wanting. Ex. *Araceæ*, or Arads.

Palmales.—Flowers with both calyx and corolla, diclinous (in some cases hermaphrodite), sessile on a branched scaly spadix; embryo vague, solid; albumen horny or fleshy. Ex. *Palmaceæ*, or Palms.

Hydrales.—Flowers perfect or imperfect, diclinous or sometimes hermaphrodite, usually scattered; embryo axile, without albumen; aquatics. Ex. *Naiadaceæ*, or Naiads.

Narcissales.—Flowers with a superior calyx and corolla, hermaphrodite, symmetrical; stamens 3 or 6 or more, all perfect; seeds with albumen. Ex. *Amaryllidaceæ*, or Amaryllids.

Amomales.—Flowers with a superior calyx and corolla, hermaphrodite, unsymmetrical; stamens 1–5, some at least of which are petaloid; seeds with albumen. Ex. *Marantaceæ*, or Marants.

Orchidales.—Flowers with a superior calyx and corolla, hermaphrodite, unsymmetrical; stamens 1–3; seeds without albumen. Ex. *Orchidaceæ*, or Orchids.

Xyridales.—Flowers half herbaceous, with an inferior calyx and corolla, hermaphrodite; 2–3 petaloideous; albumen copious. Ex. *Commelynaceæ*, or Spiderworts.

Juncales.—Flowers with an inferior calyx and corolla, hermaphrodite, herbaceous, dry, and permanent, scarious if coloured; albumen copious. Ex. *Juncaceæ*, or Rushes.

Liliales.—Flowers with an inferior calyx and corolla, hermaphrodite, hexapetaloideous, succulent, and withering; albumen copious. Ex. *Liliaceæ*, or Lilyworts.

Alismales.—Flowers with an inferior calyx and corolla, hermaphrodite, or sometimes diclinous, 3–6 petaloideous, apocarpal; albumen none. Ex. *Alismaceæ*, or Alismads.

DICTYOGENS are like Endogens, except that the leaves are net-veined, deciduous. The wood of the stem, when perennial, is arranged in a circle with a central pith. The Orders are *Dioscoreaceæ*, *Smilaceæ*, *Philesiaceæ*, *Trilliaceæ*, and *Roxburghiaceæ*.

GYMNOGENS are Flowering plants whose fructification springs from a stem the wood of which is youngest at the circumference, always concentric; the cotyledons 2 or more; and the seeds quite naked. The Orders are *Cycadeaceæ*, *Pinaceæ*, *Taxaceæ*, and *Gnetaceæ*.

EXOGENS are like Gymnogens, except that the seeds are enclosed in seed-vessels. They are distributed into four sub-classes:—

(i.) *Diclinous Exogens.*—Flowers diclinous, without any customary tendency to become hermaphrodite. The Alliances are—

Amentales.—Flowers in catkins, achlamydeous or monochlamydeous; carpels superior; embryo small, with little or no albumen. Ex. *Salicaceæ*, or Willowworts.

Urticales.—Flowers scattered, monochlamydeous; carpel single, superior; embryo large, lying in a small quantity of albumen. Ex. *Urticaceæ*, or Nettleworts.

Euphorbiales.—Flowers scattered, mono-dichlamydeous; carpels consolidated, superior; placentæ axile; embryo surrounded by abundant albumen, which is occasionally absent. Ex. *Euphorbiaceæ*, or Spurgeworts.

Quernales.—Flowers in catkins, monochlamydeous; carpels inferior; embryo amygdaloid, without albumen. Ex. *Corylaceæ*, or Mastworts.

Garryales. — Flowers monochlamydeous, sometimes amentaceous; carpels inferior; embryo minute, in a large quantity of albumen. Ex. *Garryaceæ*, or Garryads.

Menispermales. — Flowers mono-di-chlamydeous; carpels superior, disunited; embryo surrounded by abundant albumen. Ex. *Menispermaceæ*, or Menispermads.

Cucurbitales. — Flowers mono-di-chlamydeous; carpels inferior; placentæ parietal; embryo without albumen. Ex. *Cucurbitaceæ*, or Cucurbits.

Papayales.—Flowers dichlamydeous; carpels superior, consolidated; placentæ parietal; embryo surrounded by abundant albumen. Ex. *Papayaceæ*, or Papayads.

(ii.) *Hypogynous Exogens.*—Flowers hermaphrodite or polygamous; stamens entirely free from the calyx and corolla. The Alliances are:—

Violales. — Flowers mono-di-chlamydeous; placentæ parietal or sutural; embryo straight, with little or no albumen. Ex. *Violaceæ*, or Violetworts.

Cistales. — Flowers mono-di-chlamydeous; placentæ parietal or sutural; embryo curved or spiral, with little or no albumen. Ex. *Cistaceæ*, or Rock Roses.

Malvales. — Flowers mono-di-chlamydeous; placentæ axile; calyx valvate in æstivation; corolla imbricated or twisted; stamens definite or indefinite; embryo with little or no albumen. Ex. *Malvaceæ*, or Mallowworts.

Sapindales.—Flowers mono-di-chlamydeous, unsymmetrical; placentæ axile; calyx and corolla imbricated; stamens definite, rarely indefinite; embryo with little or no albumen. Ex. *Sapindaceæ*, or Soapworts.

Guttiferales.—Flowers mono-di-chlamydeous; placentæ axile; calyx imbricated; corolla imbricated or twisted; stamens indefinite, sometimes definite; embryo with little or no albumen. Ex. *Clusiaceæ*, or Guttifers.

Nymphales.—Flowers dichlamydeous; placentæ axile or sutural; stamens indefinite; embryo on the outside of a very large quantity of mealy albumen, the latter sometimes wanting. Ex. *Nymphæaceæ*, or Waterlilies.

Ranales. — Flowers mono-di-chlamydeous; placentæ sutural or axile; stamens indefinite; embryo minute, enclosed in a large quantity of fleshy or horny albumen. Ex. *Ranunculaceæ*, or Crowfoots.

Berberales.—Flowers mono-di-chlamydeous, unsymmetrical in the ovary; placentæ sutural, parietal, or axile; stamens definite; embryo enclosed in a large quantity of fleshy albumen. Ex. *Berberidaceæ*, or Berberids.

Ericales.—Flowers dichlamydeous, symmetrical in the ovary; placentæ axile; stamens definite; embryo enclosed in a large quantity of fleshy albumen; stamens occasionally adherent to the corolla. Ex. *Ericaceæ*, or Heathworts.

Rutales. — Flowers mono-di-chlamydeous, symmetrical, occasionally diclinous; placentæ axile; calyx and corolla imbricated, if present; stamens definite; embryo with little or no albumen. Ex. *Rutaceæ*, or Rueworts.

Geraniales.—Flowers mono-di-chlamydeous, symmetrical; placentæ axile; calyx imbricated; corolla twisted; stamens definite; embryo with little or no albumen. Ex. *Geraniaceæ*, or Cranesbills.

Silenales.— Flowers mono-di-chlamydeous; placentæ free, central; embryo external, curved round a little mealy albumen; carpels more than one, completely combined into a compound fruit. (Some are slightly perigynous, others diclinous.) Ex. *Caryophyllaceæ*, or Silenads.

Chenopodales.—Flowers monochlamydeous; placentæ free, central; embryo external, either curved round or applied to the surface of a little mealy or horny albumen; carpels solitary, or, if more than one, distinct. (Some slightly perigynous, others diclinous.) Ex. *Chenopodiaceæ*, or Chenopods.

Piperales.—Flowers achlamydeous; embryo minute, on the outside of a large quantity of mealy albumen. (Occasionally diclinous.) Ex. *Piperaceæ*, or Pepperworts.

(iii.) *Perigynous Exogens.*—Flowers hermaphrodite or polygamous; stamens growing to the side of either the calyx or the corolla; ovary superior, or nearly so. The Alliances are:—

Ficoidales.—Flowers mono-di-chlamydeous; placentæ central or axile; corolla, if present, polypetalous; embryo external, and curved round a small quantity of mealy albumen. Ex. *Mesembryaceæ*, or Ficoids.

Daphnales.—Flowers monochlamydeous; carpel solitary; embryo amygdaloid, without albumen. Ex. *Thymelaceæ*, or Daphnads.

Rosales. — Flowers mono-di-chlamydeous; carpels more or less distinct; placentæ sutural; seeds definite; corolla, if present, polypetalous; embryo amygdaloid, with little or no albumen. Ex. *Rosaceæ*, or Roseworts.

Saxifragales. — Flowers mono-di-chlamydeous; carpels consolidated; placentæ sutural or axile; seeds indefinite; corolla, if present, polypetalous; embryo taper, with a long radicle, and little or no albumen. Ex. *Saxifragaceæ*, or Saxifrages.

Rhamnales.—Flowers mono-di-chlamydeous; carpels consolidated; placentæ axile; fruit capsular, berried, or drupaceous; seeds definite; embryo amygdaloid, with little or no albumen. Ex. *Rhamnaceæ*, or Rhamnads.

Gentianales.—Flowers dichlamydeous, monopetalous; placentæ axile or parietal; embryo minute, or with the cotyledons much smaller than the radicle, lying in a large quantity of albumen. Ex. *Gentianaceæ*, or Gentianworts.

Solanales.—Flowers dichlamydeous, monopetalous, symmetrical; placentæ axile; fruit 2–3 celled; embryo large, lying in a small quantity of albumen. (Occasionally achlamydeous, or polypetalous.) Ex. *Solanaceæ*, or Nightshades.

Cortusales.—Flowers dichlamydeous, monopetalous, symmetrical; placentæ free, central;

embryo lying among a large quantity of albumen. (Occasionally monochlamydeous, or polypetalous.) Ex. *Primulaceæ*, or Primworts.

Echiales.—Flowers dichlamydeous, monopetalous, symmetrical or unsymmetrical; fruit nucamentaceous, consisting of several one-seeded nuts, or of clusters of them separate or separable; embryo large, with little or no albumen. (Very rarely hypogynous.) Ex. *Boraginaceæ*, or Borageworts.

Bignoniales.—Flowers dichlamydeous, monopetalous, unsymmetrical; fruit capsular or berried, with its carpels quite consolidated; placentæ axile, or parietal, or free central; embryo with little or no albumen. Ex. *Bignoniaceæ*, or Bignoniads.

(iv.) *Epigynous Exogens.*—Flowers hermaphrodite or polygamous; stamens growing to the side of either the calyx or corolla; ovary inferior or nearly so. The Alliances are:—

Campanales.—Flowers dichlamydeous, monopetalous; embryo with little or no albumen. Ex. *Campanulaceæ*, or Bellworts, and *Asteraceæ*, or Composites.

Myrtales.—Flowers dichlamydeous, polypetalous; placentæ axile; embryo with little or no albumen. (Occasionally monochlamydeous.) Ex. *Myrtaceæ*, or Myrtleblooms.

Cactales.—Flowers dichlamydeous, polypetalous; placentæ parietal; embryo with little or no albumen. Ex. *Cactaceæ*, or Indian Figs.

Grossales.—Flowers dichlamydeous, polypetalous; seeds numerous, minute; embryo small, lying in a large quantity of albumen. Ex. *Grossulariaceæ*, or Currantworts.

Cinchonales.—Flowers dichlamydeous, monopetalous; embryo minute, lying in a large quantity of albumen. Ex. *Cinchonaceæ*, or Cinchonads.

Umbellales.—Flowers dichlamydeous, polypetalous; seeds solitary, large; embryo small, lying in a large quantity of albumen. Ex. *Apiaceæ*, or Umbellifers.

Asarales.—Flowers monochlamydeous; embryo small, lying in a large quantity of albumen. Ex. *Aristolochiaceæ*, or Birthworts.

For further details of the Structure and Classification of plants, the reader may consult with advantage Lindley's *Introduction to Botany*, *Elements of Botany*, and *Vegetable Kingdom*, and the works of Balfour, Henfrey, Henslow, Oliver, and Asa Gray.

Botany Bay Gum. A gum resin produced from the *Xanthorrhœa hastilis* (alias, *resinifera*) of New Holland.

Botryllarians, Botryllariæ (Gr. βότρυς, *a bunch of grapes*). In Zoology, a family of singular compound Tunicaries or Ascidians, in which several distinct individuals are arranged in a circle round a central aperture common to the rectum of each, while the mouths are distinct and placed at the circumference.

Botryogene. A hydrated sulphate of iron, composed of 19 per cent. of sulphate of protoxide of iron, 48·3 sulphate of peroxide of iron, and 32·7 water. It is found in the great copper-mine of Fahlun in Sweden, in small crystals of a deep hyacinth-red colour, passing into ochre-yellow in massive varieties; and is often aggregated into reniform and botryoidal shapes, consisting of globules with a crystalline surface like that of a bunch of grapes.

Botryoidal (Gr. βότρυς, and εἶδος, *likeness*). In Botany, when a part (the inflorescence, for example) is clustered like a bunch of grapes. The term is used in Mineralogy when the surface of a mineral consists of a group of sections of clustered globular prominences. When the prominences are larger, and less globular, the appearance is expressed by the term *mammillated* or *mammillary*. The shapes frequently assumed by Chalcedony and Hæmatite, and certain ores of copper and manganese, are familiar examples of these modes of aggregation.

Botryolite (Gr. βότρυς, and λίθος, *stone*). A kind of Datholite occurring in mammillary concretions with a delicate fibrous texture, in the veins of magnetic iron-ore, at Arendal in Norway. It is a silicious borate of lime.

Botrytis (Gr. βότρυς). A genus of microscopic Fungi, or moulds, chiefly remarkable as containing the parasitic species of fungus which plays so important a part in the developement of the potato disease. This species is best known as *B. infestans*, though it is sometimes referred to the genus *Peronospora*. The fungous disease in silkworms called muscardine is attributable to another species, *B. Bassiana*. The nomenclature of these minute fungi is so fluctuating, owing to increased facility for studying their organisation, that the species above referred to may not improbably soon bear other names.

Bottom Heat. A term applied in Horticulture to the temperature communicated to certain soils either by fermenting and decomposing substances placed underneath them, for which purpose leaves, fresh dung, and the refuse bark of the tan-yard are often used; or by means of flues or hot-water apparatus. The system is applied to the cultivation of pineapples, grapes, melons, cucumbers, and other plants grown in hothouses, pits, or frames. It is one of the most important agents in the artificial cultivation of tender plants of whatever kind, whether flower-bearing or fruit-bearing.

Bottom Rail. In Architecture, a term used for denoting the lowest horizontal rail of a framed door.

Bottom of a Ship. Is strictly that portion of the vessel which is under water; but in a more general sense it stands for the ship itself, as in the expression, 'A trade in foreign bottoms.'

Bottomry. In Commercial Law, is in effect a mortgage of a ship, being an agreement entered into by an owner or his agent, whereby, in consideration of a sum of money advanced for the use of the ship, the borrower undertakes to repay the same, with interest, if the ship terminate her voyage successfully;

and binds or hypothecates the ship for the performance of the contract. The instrument by which this contract is effected is sometimes in the shape of a deed poll, and sometimes in that of a bond. On bottomry contracts the lender runs the risk of the voyage, and in consideration of the risk the interest he may take is unlimited. The master has authority to hypothecate a ship or its freight [RESPONDENTIA] at a foreign port, in case of necessity, for the purposes of the voyage. In such case, if the loan be not repaid within the time prescribed, the agent of the lenders applies to the Court of Admiralty, with certain affidavits, and procures authority to arrest the ship, which may be sold, if necessary, under the authority of the court. Where several loans of this description have been made on the same voyage, the last lender is entitled to priority of payment out of the proceeds of the sale.

Bouche of a Gun. A piece of copper containing the vent or orifice through which the charge of a gun is ignited.

Boudoir (Fr.). In Architecture, the word boudoir is applied to a small room or cabinet, usually near the bed-chamber or dressing-room, but also occasionally near the drawing or reception rooms, for the private retirement of the master or mistress of the house.

Bouget (properly **Boujet**). In Heraldry, an ancient water-bucket, frequently borne in shields of arms.

Bougie (Fr.). A slender flexible tube, intended for introduction into the urethra, oesophagus, or rectum, when those passages are obstructed by stricture or other disease.

Boulangerite. A sulphantimonite of lead and antimony composed of 58 per cent. of lead, 24 antimony, and 18 sulphur. It generally occurs in plumose masses, which exhibit a crystalline structure when fractured; sometimes granular and compact. The colour is bluish lead-grey, often coloured with yellow spots caused by oxidation; and the lustre is metallic. It is found abundantly in France at Molières (Dépt. du Gard); also massive, acicular and fibrous at Bottino in Tuscany; in Lapland, &c. Named after M. Boulanger, mining engineer.

Boulder. Boulders in Geological language are fragments of rock rounded by attrition lying on or within the surface, and not derived from the rocks on which they lie.

In many cases these boulders have been transported hundreds of miles, and sometimes only a few yards; but they have always been moved from their original position by the action of water or ice. A boulder of granite 42 ft. long, 27 ft. broad and 21 ft. high has been used as a natural plinth of the statue of Peter the Great at St. Petersburg. Small boulders of foreign rock have occasionally been found in the chalk and other aqueous rocks.

Boulder Clay. A deposit, often very extensive, consisting of boulders of various size, angular or rounded, mixed with sand and clay, and lying generally in an unstratified position unconformably to the other rocks on the earth's surface. Although there is no reason why such a deposit should not have been made at any geological period, boulder clay seems to be of definite age in the northern hemisphere, or at least is limited to a certain geological period. It is one of those deposits spoken of collectively as *Drift*, and would seem to be due to a time not very distant, when glaciers covered much of north European land, and icebergs drifted and were stranded over the shoals that have since been raised to form the land. [GLACIAL DRIFT.]

Boulê (Gr. *a council*). By this name the Athenian senate was designated, the constitution of which was as follows: When the people were divided into four tribes, each of these, according to the regulation of Solon, elected 100 representatives, thus making in all a deliberative body of 400 members. But when Cleisthenes increased the number of tribes to ten, the complement of the senate was raised to 500, fifty of which were sent by each tribe; when the tribes were finally increased to twelve, 100 more senators were added. All free-born Athenian citizens above thirty years of age were eligible to this office; but according to law they were obliged to undergo a strict examination of their characters and morals. The senate was originally instituted by Solon to be a check on the assembly of the whole people (ἐκκλησία), before which, according to the Athenian constitution, no measures were allowed to be brought until they had been approved by the senate. [PRYTANES.]

Boule (Fr.) or **Boule-work.** A kind of marquetry or inlaid work in woods, gilt-metal, or tortoise-shell, so called from the name of a French cabinetmaker or ébéniste, who greatly distinguished himself for ornamental work of this kind, in the reign of Louis XIV. There were two French ébénistes, father and son, of this name, which has been lately corrupted into Buhl.

Boules de Nancy. Small balls composed of potassio-pertartrate of iron: the *globuli martiales* of old pharmacy.

Boultin. In Architecture, the name given to a moulding whose section is nearly a quadrant of a circle, whose diameter being horizontal, the centre is convex with respect to a vertical to such diameter. It is more usually called the ovolo, or the quarter round.

Bounty (Fr. bonté, Lat. bonitas). The money given to a recruit for the army after his attestation and final approval. The amount of bounty in our service has varied very much from time to time according to the difficulty of obtaining recruits. A recruit now receives 1*l.* bounty, and a free kit. In America, during the present war, the bounty to recruits has risen as high as 500 dollars or about 100*l.* The system of large bounties is a great temptation to soldiers to desert after receiving them, and enlist again in other regiments, and most thinking men consider a higher rate of pay would have a better effect than bounty.

Bounty. In Commerce and the Arts, a premium paid by government to the producers, exporters, or importers of certain articles, or to those who employ ships in certain trades, when the profits resulting from these respective branches of industry are alleged to be insufficient. Bounties on production are usually given with the view of encouraging the establishment of some new branch of industry, or of fostering and extending a branch that is believed to be of paramount importance. Bounties on *exportation* and *importation* are granted to the exporters of certain British commodities on their taking oath, or in some cases giving bond, not to reland the same in England. Public opinion was formerly very divided as to the advantage of granting bounties: but at present the impolicy of such a practice appears to be almost universally admitted. For details upon this subject, see M'Culloch's *Commercial Dictionary*.

Bounty, Queen Anne's. The produce of the first fruits and tenths due to the crown [First Fruits], which were made over by Queen Anne to a corporation established in the year 1704 for the purpose of augmenting poor livings under 50*l.* a year.

Bourdon (Fr. *a staff*). In Music, the drone or bass in some musical instruments, and the pipe or string that plays it. The bass pipe in the bagpipe is so called. Hence, that part of a song that is repeated at the end of every stanza is called the burden of it.

Bourgeois (Fr.). In Printing, a kind of type one size larger than that used in this work. [Type.]

Bournonite. A triple sulphide of copper, lead, and antimony, composed of 41·8 per cent. of lead, 26 antimony, 12·8 copper, and 19·4 sulphur. It occurs in crystals (which are often cruciform), massive and disseminated; of a steel-grey colour, inclining to dull lead-grey with a tinge of black, and is opaque with a brilliant metallic lustre.

Bournonite was first found at Huel Boys, in the parish of St. Endellion [Endellionite] in Cornwall, and is so plentiful in the mines of that neighbourhood as to furnish an ore of copper: fine, and sometimes compound crystals (called *wheel-ore*), are, also, met with at Herodsfoot Mine near Liskeard. Crystals occasionally more than an inch in diameter occur in the mines of Neudorf in the Harz. Other localities are Kapnik in Transylvania, Servoz in Piedmont, Saxony, Bohemia, Hungary, Spain, &c.

Some of the Freiberg varieties of this ore contain about 0·12 per cent. of silver.

Named in honour of the count de Bournon, by whom it was first described and called Endellione.

Boustrophedon (Gr. from *βοῦς, an ox*, and *στρέφω, I turn*). A word descriptive of a mode of writing common among the early Greeks until nearly the middle of the fifth century before Christ; viz. in alternate lines from right to left and from left to right, as fields are ploughed in furrows having an alternate direction, whence the derivation. [Alphabet.]

Bout. In Agriculture, is one turn or course of a plough in ploughing a ridge.

Bovey Coal. The lignites found at Bovey Tracey in Devonshire (not far from Exeter) are called by this name. They are of the tertiary period, and have occasionally been used as fuel, chiefly for burning pottery and for brick and tile making. They burn badly, with much smoke and disagreeable odour, and are of little use.

Bow. An ancient weapon of offence, made of wood, horn, steel, or some other elastic substance, by which arrows are thrown. The force with which the arrow is propelled is proportioned to that with which the bow is bent, and to the quickness with which it recovers its former position. [Archer.]

Bow. In Music, the instrument by which the strings of the violin tribe of instruments are set in vibration.

Bows. The two sides of the fore extremity of a vessel, as the starboard and larboard bows.

Bow-string Bridge. A peculiar form of plate-iron bridge, in which the strength is obtained by means of a truss in the form of a reversed bow-string, standing as it were upon the string; the strength of this form of bridge depends upon the resistance to tension of the bow being increased by the resistance of the chord line, which is usually made of chains, or bars, like those of a suspension bridge. The best examples near London are the bridges upon the Blackwall Extension line, where they have been executed of 110 feet span, in some cases.

Bow-window. [Bay.]

Bowdichia (named after Mr. T. E. Bowdich). A genus of South American *Leguminosæ*, forming large trees with pinnated leaves, and terminal flower-panicles. The astringent Alcornoco Bark is obtained from *B. virgilioides*.

Bowenite. A bright apple-green variety of Serpentine, which is found at Smithfield, in Rhode Island, North America. It is named after Bowen, by whom it was first described (as a kind of Nephrite).

Bower-anchor. A name given to the smaller anchors, carried in the bows of a ship.

Bowline. A rope from near the middle of the weather edge or leech of a sail, leading forward. Its use is to keep the leech forward, that the wind may get at the after-side of the sail when very oblique to its direction.

Bowsprit or **Boltsprit.** In Naval Architecture, a large spar or mast, projecting from the bows, to which, in large vessels, are secured the forestays. It supports the jib and flying jib booms.

Box (Gr. *πύξος*; Lat. buxus). The hard compact wood of *Buxus sempervirens*, much used by wood engravers, and for the turner's purposes. This evergreen bush or small tree of the Euphorbiaceous order is found all over Europe, even upon the chalk hills of England; but acquires its largest dimensions in the south. It is from Turkey that the principal

part of the wood is imported into England, formerly at a duty of 5*l.* a ton: whether or not all this is really furnished by *Buxus sempervirens* is not known. It is not improbable that *Buxus balearica*, a larger species, somewhat tender in this country, may furnish a part at least of that which comes from the Mediterranean. It is said that the wood of this species is coarser and of a brighter yellow than that of the common species. The Box plant is best known by its use in gardens as an edging for borders; the kind so employed is a dwarf variety of *Buxus sempervirens*.

Box Drain. An underground drain, regularly built, with upright sides and a flat stone or brick cover, so that the transverse section resembles a box, is so called to distinguish it from the other forms of drains.

Box Girder. A form of girder resembling a box, made out of boiler plate, fastened together by means of angle irons, which are riveted respectively to the top and bottom plates. For spans of from 30 to 60 feet opening these girders present great advantages, and they are now almost exclusively used; for the greater elasticity, and the power of resisting violent impact, is far greater in this class of girders than in the old form of cast iron. Mr. Fairbairn, their inventor, has given the following formula for calculating their resistance: $W = \frac{ade}{l}$, in which W = the breaking weight applied in the centre; a = the area of the bottom flange, d = the depth of the beam in inches, e = a coefficient = 75 for wrought iron; and l = the span in inches.

Box Hauling. In Seamanship, is bringing a ship when close-hauled round upon the other tack, when she refuses to tack and there is not room to wear. By throwing the head-sails aback she gets sternway; the helm thereupon being put a-lee, the ship's head falls rapidly off from the wind, which she soon brings aft; she is then speedily rounded-to with but little loss of ground. This term is now obsolete.

Boxing the Compass. Repeating the thirty-two points of the compass in order.

Boxing Off. Throwing the head-sails aback to force the ship's head rapidly off the wind.

Boxings. [LINING.]

Boy-bishop. During the middle ages, the custom grew up of allowing the choristers of cathedrals to choose yearly one of their number to act the part of a bishop. The practice was permitted probably from the same motives which suffered the mummeries of the Abbot of Unreason (a graphic account of which may be found in Sir Walter Scott's romance of *The Monastery*). If the boy-bishop died within his short period of office, he was buried in his episcopal robes. A tomb with the effigy of a boy so clothed may be seen in Salisbury Cathedral.

Boyle's Fuming Liquor. Bisulphide of ammonium. It is a deep-yellow fœtid liquid.

Boyle's Law. 'The volume of a gas is inversely as the pressure.' For example, if we double the pressure upon a gas its bulk will be reduced to one-half. If the pressure be trebled the volume will be one-third, and so on.

Braccate (Lat. braccatus, from braccæ, *breeches*). In Ornithology, when the feet are concealed by long feathers descending from the tibiæ.

Brace (Fr. bras, *the arm*). In Architecture, an inclined piece of timber used in trussed partitions, and roofs, in order to form a triangle by which the assemblage of pieces composing the frame is stiffened. When braces are used in roofs and partitions, they should as far as possible be introduced in pairs, and be framed in opposite directions to one another.

BRACE. In Music, the line or bracket at the beginning of each set of staves which ties them together in a vertical direction.

BRACE. In Seamanship, a rope fastened to or rove through a block at the yardarm, for the purpose of trimming the yards horizontally.

Brachelytra (Gr. βραχύς, *short*; ἔλυτρον, *sheath*). The name of an extensive group of Coleopterous insects, including all such as have the elytra so short as not to exceed one-third the length of the abdomen. To this section belongs the well-known species called the devil's coach-horse (*Staphylinus olens*).

Brachial (Lat. brachium, *the arm*). Belonging to the arm; as brachial nerves, vessels, &c.

Brachinus. A genus of Coleopterous insects, now the type of a family (*Brachinidæ*), including those singular beetles which from their defensive anal explosions are termed 'bombardiers.' Of these there are five British species, the best known of which is the *Brachinus crepitans* of Linnæus.

Brachionis. The name given by Müller to a genus of Rotiferous Infusorial Animalcules, since subdivided into many distinct genera.

Brachiopods, Brachiopoda (Gr. βραχίων, an arm; ποῦς, a foot). A class of bivalve Mollusca characterised by having the mantle organised so as to be serviceable for respiration, and by having two long, fleshy, ciliated, spiral arms, or labiate processes; whence Cuvier conceived the name, which in his system designates a distinct class of Acephala. [PALLIOBRANCHIATES.] The following is a list of the orders of the class *Brachiopoda: Terebratulidæ, Spiriferidæ, Rhynchonellidæ, Orthidæ, Productidæ, Cranidæ, Discinidæ, Lingulidæ.*

Brachistochrone (Gr. βράχιστος, *shortest*; χρόνος, *time*). The plane curve down which a material particle must fall in order to pass, in the shortest possible time, from the upper to the lower of two given points not in the same vertical line. It is the common cycloid.

The problem of the *Brachistochrone* is a celebrated one in the history of mathematics. It was proposed by John Bernouilli in the Leipzic *Acta Eruditorum* for June 1696, and solved by Newton, James Bernouilli (John's brother), and the marquis de l'Hôpital. The consideration of this problem led James Bernoulli to others of kindred character, relating to isoperimetrical figures, the adequate treatment of which required a different calculus from any then

known. This calculus, the calculus of variations, was in due time developed by Euler, Lagrange and others, and constitutes one of the most important branches of the higher mathematics. It is by this calculus that the problem of the *brachistochrone* is now always solved.

Brachium (Lat. *arm*). In Mammalogy, this term is restricted to the second segment of the anterior extremity. In Entomology, it signifies the first pair of legs of Hexapods, the direction of which is usually towards the head.

Brachycatalectic (Gr. βραχύς, *short*, and καταληκτικός, *deficient*). A verse wanting two syllables to complete its length (in Greek and Latin poetry).

Brachygraphy (Gr. βραχύς, *short*, and γράφω, *I write*). The art of writing by abbreviations. [TACHYGRAPHY.] The notæ Tironianæ, among the Romans, were a species of shorthand invented by one Tiro, a freedman of Cicero.

Brachykephalic (Gr. βραχύς, *short*, and κεφαλή, *head*). This term is applied by Prof. Retzius to all skulls whose transverse diameter is more than $\frac{8}{10}$ of their longitudinal diameter. It is supposed that a brachykephalic race of men existed in Europe before that continent was inhabited by the Celtic tribes. The classification of human skulls into brachy- and dolicho-kephalic is merely artificial, and does not denote a difference of race. Brachy- and dolicho-kephalic heads are to be found in nearly all the races of man. The majority of brachykephalic skulls are to be found in the Turanian or 'Mongol' nations. [DOLICHOKEPHALIC; MESATIKEPHALIC.]

Brachypterous (Gr. βραχύς, *short*; πτερόν, *wing*). In Ornithology, when the folded wings of a bird do not reach to the base of the tail.

Brachyures, Brachyura (Gr. βραχύς, *short*, and οὐρά, *a tail*). A tribe of Decapodous Crustacea, in which the tail or post-abdomen is short, and folded beneath the trunk; commonly called 'crabs.'

Bracket (Fr. brague, *a mortise*: Latham). In Architecture, the word bracket is often employed to signify an ornament in the shape of a console standing isolated upon the face of a wall; it is used for this purpose both in classical and mediæval architecture, with the differences attending each course of treatment.

Bracklesham Beds. The name given in England to the part of the Eocene deposits overlying the 'London clay' series. The Bracklesham beds appear to be the equivalent of the CALCAIRE GROSSIER. They are well seen at Alum Bay in the Isle of Wight, and on the opposite Hampshire coast, attaining in some places a thickness of 500 feet.

The Bracklesham beds are also the equivalents, in time, of the deposits of the Brussels basin and a part of the great NUMMULITIC FORMATION. Most of the foraminiferous deposits of that formation are, however, somewhat older.

The Bracklesham beds are generally fossiliferous, and contain large series of characteristic fossils, careful lists of which have been published by Mr. Prestwich in the *Quarterly Journal of the Geological Society*, vol. x. (1854) p. 450.

Bracon. A Fabrician genus of Hymenopterous insects of the parasitic tribe of Pupivorous Ichneumons: it is now the type of a family (*Braconidæ*), distinguished from the true Ichneumons by having the maxillary palps five-jointed, and the labial ones either three or four jointed, and by wanting the internal discoidal cell of the upper wings. The genera of this family are *Bracon* proper; *Aphidius*, the species of which prey upon the plant-lice; *Stephanus*, *Cœlinius*, *Spathius*, *Perilitus*, *Hybrizon*, *Leiophron*, *Agathis*, *Microdus*, *Hormius*, *Ichneutes*, *Microgaster*, and *Blacus*.

Bract (Lat. bractea, *a thin plate or leaf*). An altered leaf, which is placed at the base of a flower on the outside of the calyx. It is the first attempt made by the common leaves to change into the floral organs. In general the bract is small and inconspicuous, but it occasionally acquires a considerable size and a brilliant colour, as in the Brazilian pine-apple, and more especially *Poinsettia pulcherrima*, and in the various kinds of *Arum*, in which it constitutes the large enveloping leaf, called spathe, in which the spadix of those extraordinary plants is enveloped. This word forms the adjectives *bractescent*, assuming the appearance of a bract; *bracteal*, furnished with bracts; *bracteolate*, having little bracts. A *cupule* is a collection of bracts united into a cup; an *involucre* denotes the same organs arranged in a whorl. The flowers of grasses and cyperaceous plants consist of nothing but little bracts called *pales* and *glumes*.

Bradawl. A small tool used by Joiners for the purpose of boring wood: it is sometimes used as a screw-driver for small screws.

Bradford Clay. The name given to the middle member of the upper division of the Lower Oolites as developed in the West of England. It nearly corresponds in age with the limestones of the Great Oolite, but is generally a pale greyish clay with little calcareous matter, though enclosing bands of impure limestone. It is nowhere more than sixty feet thick, and is local; but it is remarkable for the abundance of a peculiar fossil, the *Apiocrinite*. There are one or two species of *Terebratula* also characteristic of this deposit. The Bradford clay often passes insensibly either into the overlying or underlying beds.

Bradypods, Bradypoda (Gr. βραδύπους, *slow-footed*). A family of Macronykous or Edentate Mammals, including the two-toed and three-toed sloths.

Bragite. A mineral of doubtful identity, found at Helbe in Norway. It is a columbate of yttria, &c., and is probably identical with Tyrite.

Brahma (Hin.). The name of a divinity in the Hindu Mythology. As we learn from the Sanscrit lexilogists, the epithets applied to

this divinity are very numerous: some of the most usual being, '*Swayambhu*, the self-existent; *Parameshti*, who abides in the most exalted places; *Pitamaha*, the great father; *Prajâpati*, the lord of creatures; *Lokesa*, the ruler of the world,' &c. *Brahm*, the highest divinity of the Hindus, to whose name so deep reverence is attached that it is considered criminal to pronounce it, is said to have given birth to Brahma, Vishnu, and Siva simultaneously; and to have allotted to the first the province of creating, to the second that of preserving, and to the third that of destroying. Accordingly, ever since the creation of the world Brahma has had little or nothing to do, and it will not be till the tenth avatar or incarnation that his services will be put in requisition, when this world is to undergo total annihilation. Meanwhile, however, the other deities, Vishnu and Siva, are constantly engaged in their respective duties of preservation and destruction; and the Hindus lavish all their adoration upon those divinities from whom they expect to derive immediate advantage. Brahma is usually represented with four heads and four hands, either reclining upon a lote tree (the emblem of creation among the Hindus) or riding upon a swan.

Brahmans or Brahmins. The first or highest of the four castes of Hindus, said to have proceeded from the mouth of Brahm (the seat of wisdom). They form the learned or sacerdotal class; and its members have maintained a more extensive sway than the priests of any other nation. Their chief privileges consist in reading the Veda or sacred volume, in instituting sacrifices, in imparting religious instruction, in asking alms, and in exemption from capital punishment. The whole life of the Brahmans is devoted to the study of the sacred writings, and is divided into four periods. The first begins at the age of seven, when the duty of the novice consists in learning to read and write, and studying in the Veda. In the second stage of a Brahman's life he is allowed to marry, and to engage in commercial speculations. In the third his religious duties become more numerous, and must be rigidly performed. But in the fourth period, the Brahman is admitted to personal communication with the Deity; and this stage is reckoned so preeminently holy, that in a single generation it imparts a greater stock of religious importance than is attainable by any other means in a thousand years. The importance of the Brahmans dates from a time later than that of the early Vedic hymns, in which Brahma himself is not known as a god, and the Brahman appears as one among a number of priests in no way his inferiors. (Prof. H. H. Wilson, in *Edinburgh Review*, No. 228, p. 381 &c.) After the promulgation of the Code of Menu, the Brahmans gradually established their supremacy. Of ancient Brahmanical science the principal remains are their astronomical and trigonometrical methods, both of which have given rise to frequent and learned discussion. Among the modern Brahmans we look in vain for the deep learning that characterised the ancient members of this order: for, with the exception of metaphysical disquisitions, which have always been a favourite study among them, the learning of the present race of Brahmans is exceedingly meagre. Nor is it merely in point of learning that the modern Brahmans have degenerated from their ancestors. Their morals are woefully deteriorated; and while they are the sole depositaries and ministers of a religion which in point of purity and sublimity of doctrine yields only to the Christian, their conduct is characterised by the most vile and licentious practices; a spirit of avarice, falsehood, and revenge is everywhere visible; and in many cases superstition and fanaticism have been exchanged for infidelity and atheism. (Mill's *British India; Asiatic Researches*, passim; Coleman's *Hindoo Mythology*; Sir William Jones's *History*; Max Müller's *History of Sanskrit Literature.*)

Brails. On Shipboard, are small ropes employed in gathering up to a yard the bottom and skirts of its sail, preparatory to furling. They lessen the trouble and danger of furling sails, and allow of sail being rapidly reduced by hauling the brails either from the deck or top. When the brails are hauled taut, the sail is said to be 'brailed up.'

Brain (A.-Sax. brægen). The chemical examination of the brain of animals was first undertaken by Vauquelin, who found in the human brain 80 water, 7 albumen, 4·53 white fatty matter, 0·70 red fatty matter, 1·12 osmazome, 1·5 phosphorus; acids, salts, and sulphur, 5·15. An elaborate dissertation upon the composition of brain has more lately been published by M. Couerbe (*Annales de Chim. et Phys.* lvi. 160). He finds a large proportion of *cholesterine* in it: and asserts, as the result of repeated examinations, that the proportion of phosphorus in the brain of persons of sound intellect is from 2 to 2·5 per cent.: in the brain of maniacs it is from 3 to 4·5, and in that of idiots only from 1 to 1·5 per cent.

Brain, Human, Anatomy of. The brain, or the general mass of nervous matter which occupies the cavity of the skull, constitutes about one thirty-fifth of the weight of the body; it is divided by anatomists into the *cerebrum*, which occupies the whole of the superior part of the cavity of the cranium; the *cerebellum*, which occupies the lower back part; and the *medulla oblongata*, which is the smallest portion, lying at the base of the cranium, beneath the cerebrum and cerebellum, and passing out of the great occipital foramen becomes as it were the origin of the spinal marrow. The brain is covered by three membranes, two of which are termed *matres*, from the old idea of their giving rise to all the other membranes of the body. The external membrane, more firm than the others, is termed *dura mater*: it is very dense and fibrous, and adheres everywhere to the inner surface of the cranium, to which it is connected by its vessels; its inner surface is

smooth, and it sends off several folds, or *processes*, as they are called, which descend between certain portions of the brain. Of these the principal is the superior longitudinal process, or *falx cerebri*, which descends from the fore to the back part of the skull between the hemispheres of the brain; from its posterior termination it sends off a layer or expansion, which extends across the back of the skull, and is called the *tentorium*, separating the cerebrum from the cerebellum; from the middle of the tentorium another membranous expansion descends between the lobes of the cerebellum, and terminates at the edge of the great occipital hole, or *foramen magnum*; this is termed the *falx cerebelli*. There are certain spaces or *sinuses* formed in the layers of the dura mater, which perform the office of veins in regard to the blood returning from different parts of the brain, by which any venous pressure upon the substance of the brain is prevented.

When the dura mater is removed, a thin transparent membrane investing the surface and convolutions of the brain is brought to view, which from the delicacy of its texture has been called the *arachnoid* membrane. It is not apparently vascular, and does not pass into the depressions between the convolutions; and it is not easily separable from the third membrane, or *pia mater*, which is also extremely tender and delicate but is highly vascular, and from it the blood-vessels merge into the substance of the brain, ramifying with great minuteness upon its surface: it lines all the convolutions and cavities of the brain. On removing the upper part of the cranium, and turning aside the dura mater, the brain is seen, divided longitudinally into two ovoid hemispheres, separated, as already stated, by the falx. Upon the under side each hemisphere is seen to be divided into three lobes; the two anterior lobes rest upon the orbital plates of the frontal bone; the middle lobes lie upon the fossæ formed by the temporal and sphenoid bones; and the posterior lobes rest upon the tentorium. The superficial convolutions of the brain are divided by clefts, of about an inch in depth. On cutting into its substance, the exterior part of the brain appears of a different colour from the interior, and has been termed the cineritious or cortical substance; it is greyish brown, very soft, and exhibits no appearance of a fibrous texture. Some suppose that it is glandular, and constituted almost entirely of vessels and cellular membrane; it covers the whole of the brain, and is about the tenth of an inch in thickness. The inner substance, termed the white or medullary part of the brain, is of a firmer texture, highly vascular, and when minutely examined appears fibrous, the fibres decussating with each other, and occasionally combining to form commissures.

The *cerebellum*, when viewed from below, is of an elliptical shape, its longest diameter being from side to side, and is divided into two hemispheres separated by the falx cerebelli. In the centre of the upper part of the cerebellum there is a prominence, termed the *vermiform process*; and the whole surface is fissured or sulcated, the pia mater passing between the fissures and conveying vessels to the substance, whilst the arachnoid tunic is merely extended over them.

Such is an outline of the anatomy of the human brain; the details can only be fully understood by reference to illustrative plates upon a scale which would be incompatible with the plan of this work.

It has been already stated that in man the brain averages in weight 1-35th of the body; it weighs, in fact, about two pounds and a half: in quadrupeds its relative bulk is remarkably smaller; in the dog it averages 1-120th of the weight of the animal; in the horse 1-450th; in the sheep 1-750th; and in the ox 1-800th. This statement has been adduced to show the direct relation between the bulk of the brain and the quantity of mind, the above animals being ranged in the order of their docility and intelligence.

On making a vertical section of either hemisphere of the cerebellum, a central white substance becomes apparent, which ramifies in an arborescent form, and is called *arbor vitæ*; the exterior covering is grey. In front of the cerebellum is a protuberance, termed *pons Varolii* or *tuber annulare*; it is divided by a central groove into two halves, and connected with the cerebrum and cerebellum severally by two thick white chords called *crura*; the former, or crura cerebri, pass from the tuber forwards and outwards, under the middle part of each hemisphere, in which they are lost; and the latter, the crura cerebelli, are continued backwards and outwards, and terminate in either hemisphere of the cerebellum. The portion of the brain between the tuber annulare and the foramen of the occipital bone is called the *medulla oblongata*, and is continued into the spinal chord; on its anterior surface are four contiguous projections; the two interior are called *corpora pyramidalia*, and the two exterior *corpora olivaria*. On carefully removing the membranes which cover the medulla oblongata, and gently opening its middle groove, several white bands are seen passing obliquely from one side to the other, and mutually interwoven, and are termed the *decussating bands*.

The two sides of the brain are mutually connected by commissures or medullary bands, and those of the cerebellum by the pons Varolii. The principal connection of the hemispheres of the cerebrum is by a broad medullary band, called the *corpus callosum*. The occasional intervals which separate the parts of the brain are termed *ventricles*, the largest of which are the two *lateral ventricles* in the interior of each hemisphere; their figure is irregular, and they are separated by a tender layer of cerebral matter termed the *septum lucidum*; they are lined by the pia mater. The *middle* or *third ventricle* is a fissure between two convex eminences, situated at the middle and back of the lateral ventricles, and termed *thalami optici*. The *fourth ventricle*, or *ventricle of the cere-*

bellum, is a cavity between the cerebrum, the tuber annulare, and the medulla oblongata.

Braird. In the Agriculture and Gardening of Scotland, the term braird is applied to the springing up of seeds, which, when they come up well, are said to have a fine braird.

Brake. In Agriculture, a large harrow.

Bran (Fr.). The husk of wheat which immediately covers the grain, and which remains in the bolting machine. It is gently laxative; an infusion of it, under the name of *bran tea*, is frequently used as a domestic remedy for coughs and hoarseness. *Calico printers* employ bran and warm water with great success to remove colouring matter from those parts of their goods which are not mordanted.

Branch Coal. A provincial term, applied, in Yorkshire, to Cannel and other kinds of coal, when the layers appear to traverse the main body of the seam, from which they differ in quality, being generally more inflammable.

The *Glô Spagod* or Branching Coal of South Wales is so called in consequence of the swelling or branching which takes place during combustion and in the process of coking. In some varieties, as in that from the Clyngwernon seam, this peculiarity is carried to such an extent as to render the coke almost as light and porous as wood-charcoal. (*History of Fossil Fuel*, p. 414.)

Branchiae (Gr. *βράγχια, the gills of a fish*). The term applied to all vascular organs of an animal body which are destined to submit the circulating fluid in a state of minute subdivision, for the purpose of respiration, to the influence of air contained in water.

Branchiopods, Branchiopoda (Gr. βράγχια, and πούς, *a foot*). An order of Crustaceans, in which the locomotive extremities fulfil the functions of gills.

Branchiostegans, Branchiostegi (Gr. βράγχια, and *στέγω, I cover*). A tribe of cartilaginous fishes, comprehending those in which the gills are free, and covered by a membrane; including the sturgeon and chimaera.

Branchite. A colourless translucent mineral hydrocarbon resembling Scheererite, from the Brown Coal of Mount Vaso, in Tuscany.

Brandisite. A variety of Clintonite, occurring in crystals lining cavities in a rock which is chiefly composed of Pyroxene, at Toal della Foja de Monzani, in the Tyrol.

Brandy (Ger. Brannt-wein, *burnt-wine*; the old English forms, brandwine and brandywine, are now obsolete). The spirituous liquor obtained by the distillation of wine. When pure it is perfectly colourless, and only acquires a pale brown or yellow tint from the cask. The deep colour of common brandy, intended to imitate that which it acquires from great age in the cask, is generally given by the addition of burnt sugar. The average proportion of alcohol in brandy varies from 48 to 54 per cent. The best brandy is made in France, the preference being generally given to that shipped from Cognac. The duties on brandy and other foreign spirits, which had been reduced by Sir R. Peel from 22*s*. 6*d*. a gallon to 15*s*., were further reduced in 1860 to 8*s*. 6*d*., the amount levied on English spirits.

Brash. A local name, but one sufficiently common in English geology. It is meant to designate a mass of broken and angular fragments derived from a subjacent rock, generally limestone. The CORNBRASH is a rubbly rock of this kind in the oolites, making by its decomposition a good corn land. For derivation &c. see Bristow's *Descriptive Catalogue of Rock Specimens* in Mus. Pract. Geol. [CORNSTONE.]

Brass (A.-Sax. bras). An alloy of copper and zinc. The proportions vary according to the required colour: four parts of copper and one of zinc form an excellent brass. It is usually made by heating copper plates in a mixture of native oxide of zinc, or calamine, and charcoal.

BRASS. A name given in South Wales to Clay-ironstone when mixed with coaly matter. In other districts the term 'Brass' is applied to the Iron Pyrites found associated with, and in, beds of coal. It is often of considerable value for making green vitriol or copperas, and is used for that purpose in Northumberland, Durham, Yorkshire, Lancashire and Scotland.

Brass or **Coal Brasses.** Names given to the Iron Pyrites (sulphide of iron) found in the coal measures. They are employed in Yorkshire and on the Tyne in the manufacture of copperas. (Ure's *Dict. of Arts, Manufactures and Mines*, vol. i. p. 719.)

Brasses, Monumental. This name has been given to monumental slabs of brass, on which are carved effigies in outline. Of such memorials, the earliest on record is that of Simon de Beauchamp, who died at the beginning of the thirteenth century; but the earliest of the brasses which have been preserved to the present time is that of Sir John d'Abernon, who died in 1277 and was buried at Stoke d'Abernon in Surrey. The value of such monuments, as illustrating the costume, manners, and habits of our ancestors, can scarcely be overrated; but their number has unfortunately been greatly lessened by the wanton spoliation and destruction which took place at the Reformation and still more during the civil war of Charles I. and the Commonwealth. (*Manual of Monumental Brasses*, Oxford 1848. See also the works of Waller, Boutell, and Haines on the same subject.) The use of such memorials is again coming into fashion; but the habit of using fancy dresses for the effigies of persons deceased cannot be too strongly blamed. In Westminster Abbey is a monumental brass, on which Sir Thomas Wilson, the deliverer of La Valette in 1815, is represented with his wife in a costume belonging to the age of the Plantagenets. Memorials which would otherwise be most valuable, are thus rendered not only worthless but deceptive. (*Edinburgh Review*, July 1863, p. 73.)

Brassage. A sum formerly levied to defray the expense of coinage, and taken out of the

intrinsic value of the co..n. The term is supposed to be derived from *brachiorum labor.*

Brassart. In Plate Armour, the piece which protected the upper arm, between the shoulder-piece and the elbow.

Brassica (Celt. bresic, *cabbage*). One of the most extensively cultivated genera of the *Cruciferæ*, yielding as garden vegetables the Cabbage, Kale, Broccoli, Cauliflower and Turnip, with their varieties; and as farm crops, the Turnip, the Swedish Turnip and the Rape. The Mustards are sometimes associated with *Brassica*, sometimes separated under the name of *Sinapis.*

Brassicaceæ (Brassica, one of the genera). One of the names given to the natural order *Cruciferæ.*

Brattice. In Mining Engineering, the great general shaft is divided, by a partition of iron plate and other fit material called a brattice, into two chambers, which serve as up-cast and down-cast shaft for the ventilation. Mining engineers also use the term to express the separation of the currents, which takes place occasionally on the sides of a shaft, which are then said to constitute a *natural brattice*, or one independent of any artificial ventilation.

Braunite. A native sesquioxide of manganese, composed, when pure, of 69·68 per cent. of manganese and 30·32 oxygen. It occurs both crystalline and amorphous, of a dark brownish-black colour, with a submetallic lustre. It is distinguished from other ores of manganese by its greater hardness.

Braxy. A disease in sheep, caused apparently by constipation. It is very prevalent in the Highlands of Scotland.

Brayera (named after Dr. Brayer, who observed its medicinal properties). A genus of *Rosaceæ* found in Abyssinia, where it has long been in use as an efficacious vermifuge. *B. anthelmintica*, the only species, is a tree with pinnated leaves, and diœcious flowers. The female flowers want both stamens and petals.

Brazil Nut. A South American fruit, commonly sold in the markets of London; it is the seed of a large fruit-tree, called *Bertholletia excelsa.*

Brazil Wood. A wood imported from South America and the West Indies, where it is produced by certain species of *Cæsalpinia*, especially *C. echinata* and *C. brasiliensis*—large trees with pinnated leaves, showy yellow flowers, and long richly coloured stamens. It is used for the preparation of a red dye, but the consumption of it in this country is inconsiderable.

Brazing. The act of joining together two pieces of metal by means of brass solder melted between them. The best description of solder is made of 9 parts of brass to 1 of tin; hard solder is made of 2 parts of common brass, ⅞ of a part of zinc, and ½ of a part of tin. The solder for the precious metals is made of 66 parts of silver to 33 parts of common brass.

Breach. In Fortification, a gap or opening made in any part of the walls of the besieged place by the cannon or mines of the besiegers.

Bread (A.-Sax.; Ger. brod). This important article of food is made of the flour of different grains; but it is only those which contain gluten that admit of conversion into a light or porous and spongy bread, of which *wheaten bread* furnishes the best example. When flour is made into a *dough* by the addition of a little water, rolled out into thin cakes, and more or less baked, it forms *biscuit.* For the formation of *bread*, a certain degree of fermentation, not unlike vinous fermentation, is requisite, care being taken to avoid acetous fermentation, which renders the bread sour and disagreeable. If dough be left to itself in a moderately warm place (between 80° and 120°), fermentation comes on. When this is rapid, it is *acetous*; so that to effect that kind of fermentation requisite for the production of the best bread, a *ferment* is added, which is either *leaven* (dough already in a fermenting state) or *yeast* (the matter which collects in beer in the act of fermentation). Of these ferments, leaven is slow and uncertain; yeast is more effective; and when clean and good, it rapidly induces *panary fermentation*; but it is often bitter, and sometimes has a disagreeable smell and taste.

All, then, that is essential to make a loaf of bread, is dough to which a certain quantity of yeast has been added. This mixture is put into any convenient mould, or form, or shaped into a mass; and after having been kept for a short time in rather a warm place, so that fermentation may have begun, it is subjected to the process of baking in a proper oven. Carbonic acid is generated; and the viscidity or texture of the dough preventing the immediate escape of that gas, the whole mass is puffed up by it, and a light porous bread is the result. Along with the carbonic acid traces of alcohol are produced, but so insignificant as not to be worth notice; hence the attempts to collect it upon a large scale have entirely failed in an economical point of view. Other flour besides that of wheat will under similar circumstances undergo panary fermentation; but the result is a heavy, unpalatable, and often indigestible bread; so that the addition of a certain quantity of wheat flour is almost always made. It is the *gluten* in wheat which thus peculiarly fits it for the manufacture of bread, chiefly in consequence of the tough and elastic viscidity which it confers upon the dough.

It is well known that *home-made bread* and *baker's bread* are two very different things. The former is usually sweeter, lighter, and more retentive of moisture: the latter, if eaten soon after it has cooled, is pleasant and spongy; but if kept for more than two or three days, it becomes harsh and unpalatable. The cause of this difference may perhaps be obvious from the following details of the operations of the wholesale baker.

In making his dough he takes the water, or part of it, which he intends to use, and having slightly warmed it, dissolves in it a certain portion of salt; then he adds the yeast, and then a certain quantity of flour. This mixture is set

aside in a warm place, where it soon begins to ferment. This process is called *setting the sponge*; and according to the relation which the water in it bears to the whole quantity to be used in the dough, it is called whole, half, or quarter sponge. The evolution of carbonic acid causes the sponge to heave and swell; and when the surface bursts it subsides, and then swells again and so on; but the baker is careful to use it before this fermentation has communicated sourness to the mass. He then adds to the sponge the remaining quantity of flour, water, and salt which may be required to form dough of proper quality and consistence, and incorporates the whole by long and laborious kneadings till the entire mass acquires uniformity, and is so tough and elastic as to bear the pressure of the hand without adhering to it. It is then left for a few hours, during which fermentation goes on; and the inflated mass is again kneaded, so as to break down any lumps or portions which had accidentally escaped diffusion in the first operation, and to confer perfect uniformity on the whole. The dough is then weighed out into loaves, which are shaped, and put aside in a warm place for an hour or two, during which they swell up to about double their original size; they are then put into the oven and baked; during which operation they again enlarge considerably in bulk, in consequence of the dilatation of the previously generated carbonic acid pent up in the dough: for, as soon as the mass is exposed to the heat of the oven, the fermentation is ended.

If we compare the baked loaf with the flour of which it is composed, we shall find that panary fermentation has produced a considerable change in the latter. The gluten and the starch, which (exclusive of a little sugar) were the principal components of the flour, have mutually acted upon and partially altered each other; the toughness and viscidity of the gluten is gone, and the starch no longer forms a gelatinous mixture with hot water; a little sugar is generally formed, as well as alcohol; but the principal cause of the change in the characters of the flour is the evolution of carbon and of oxygen in the form of carbonic acid, the production of which is independent of the presence of external oxygen (or of air). Small quantities of alum are generally used by the London bakers with the view of whitening the bread; for it may be observed, that whatever may be the quality of the flour which is used, home-made bread is of a comparatively dingy hue. According to Mr. Accum (*On the Adulteration of Food*), the requisite quantity of alum for this purpose depends upon the quality of the flour. The mealman, he says, makes different sorts of flour from the same kind of grain. The best flour is chiefly used for biscuits and pastry, and the inferior kinds for bread. In London several kinds of wheaten flour are brought into the market; they are called fine flour, seconds, middlings, coarse middlings, and twenty-penny. Beans and peas are also, according to the same authority, frequently ground up with London flour. The smallest quantity of alum used is from three to four ounces to the sack of flour of 240 pounds. Much has been said as to the deleterious effects of the alum in London bread, in producing dyspepsia and constipation; but the quantity used is too small to justify such statements.

Another article occasionally employed in bread-making is carbonate of ammonia. As it is dissipated by the heat of the oven, none remains in the baked loaf. It renders the bread light, and perhaps neutralises any acid that may have been formed (exclusive of carbonic acid); but it is not much employed. To some kinds of biscuits it gives a peculiar shortness. The French and Belgian bakers have been accused of using sulphate of copper for improving the colour and quality of bread; this, if employed in infinitesimal quantities only, is a really dangerous addition. According to Mr. E. Davy, bread, especially bread made of indifferent flour, is materially improved by the addition of a little carbonate of magnesia, in the proportion of twenty to thirty grains to the pound of flour; it requires to be very intimately mixed with the dough. The most nefarious adulteration of bread consists, perhaps, in the addition of certain insipid and colourless earthy substances; such as pipe-clay, porcelain-clay, and plaster of Paris. These, however, are rarely resorted to; though in one instance the writer of this article had occasion to examine some *biscuits*, which were adulterated with gypsum to the amount of 10 per cent.

The manufacture of bread as carried on in this country is generally a dirty and disgusting process; it is usually conducted in cellars, infested with beetles, and the kneading of the dough is performed with the naked arms or feet of the operators. It has lately been proposed to supersede these processes by the use of machinery, and a company has been established for effecting this desirable change.

Unfermented Bread.—Instead of deriving the carbonic acid (which gives lightness and porosity to the bread) from fermentation, it has been proposed to substitute less indirect processes for its introduction into the dough. Thus, instead of adding salt to the mixture of flour and water, hydrochloric acid and carbonate of soda, in such exact proportions as to form common salt (chloride of sodium), have been used; in this case the evolved carbonic acid is received into the dough, causing it to rise to the same extent as by fermentation, and good and palatable bread may be thus made; but it is very difficult to obtain it free from small doughy lumps, and the commercial hydrochloric acid often contains traces of arsenic.

Aërated Bread.—Under this name loaves are made by Dr. Dauglish's patent, in which an aqueous solution of carbonic acid prepared under great pressure is mixed with the flour in a proper apparatus, so as to produce a vesicular dough when the pressure is removed. The

process is rapid, and prevents such deteriorations of the flour as are said to be attendant on fermentation in the usual way. (See, in reference to the manufacture and composition of bread, Ure's *Dictionary*; Watts' *Dictionary*; Muspratt's *Chemistry*.)

New and Stale Bread.—It has generally been assumed that the difference between newly baked bread and that which has been kept for a few days depends merely upon relative dryness, or upon the loss of water by the latter. But it has been shown by Boussingault (*Ann. Chim. et Phys.* xxxvi. 492) that a stale loaf which had been kept for six days had only lost about 1 per cent. of water, and that all the qualities of new bread were restored by placing it for an hour in the oven. So also, when a thick slice of stale bread is toasted, the crumby interior loses its harshness, and acquires the taste and texture of newly baked. The difference, therefore, between new and stale bread is supposed to depend upon difference in molecular arrangement.

Break. In Architecture, the projection from the face of a building is called a break, whether it arise in plan or in elevation. It is one of the most legitimate ways of securing variety of line; but the exaggerated effects of the break introduced in the cinquecento and the Louis XIV. styles of architecture prove that considerable discretion must be exercised in their use. They should be caused by some necessity of the plan, or of the disposition of the structure: a break, introduced merely as a break, is a decided mistake in a composition.

Breakers. Waves that break, or fall over, from the shallowness of the water. In a gale, the tops of the seas generally break in this way, more or less, from the progressive motion of the water at the surface before the wind, which is exceedingly dangerous for open boats. This is never confounded with the falling over of the whole wave, as the surf falls over on the beach.

Breaking Joint. In Architecture, that disposition of stones and bricks in their courses by which vertical joints are not allowed to fall over each other. (See diagrams to BOND, ENGLISH and FLEMISH.)

Breakwater. An artificial bank of stones, or a timber structure, sunk to break the violence of the sea before its entrance into a roadstead or harbour. The Roman emperors erected many structures of this description, which survive to the present day to show the mode of construction adopted, such as the breakwater of the harbour of Civita Vecchia, still in good repair, and many of the ports of Italy. More recently the system of thus forming an artificial barrier to the sea has been adopted at Cherbourg and Cette in France; at Plymouth and Portland in England; at Buffalo and at the mouth of the Delaware in the United States, in all of which positions breakwaters are formed of immense magnitude. The mode of construction adopted in all such cases is to cast down large stones, from either ships or railway waggons, whenever it is possible to connect the works with the mainland; and to allow them to assume their angle of repose under the action of the tides and currents. The top of the masonry structure is then covered with large blocks of artificial stone as at Cherbourg, or with paving laid with a regular slope as at Plymouth; and a wall is erected upon the top of the sea slope, after the work has attained its stability under the action of the sea. Cherbourg breakwater is the most gigantic work of the kind executed in ancient or modern times, and it is a noble monument of the skill and perseverance of the French engineers; Plymouth breakwater is much smaller, but it was completed within a much shorter period than its French rival; we have still to learn whether Portland breakwater is sufficiently settled to resist the effects of the sea; for at Cherbourg a storm occurred in 1808 which swept away all the upper structure, and 400 men of the garrison stationed on it, after it had supported the attack of several winters. The Buffalo breakwater is erected to protect the harbour against the storms of Lake Erie, which are often very serious.

Bream (Fr. brame). The name of a soft-finned fish, common in many of the lakes and rivers of England, and one that breeds freely and thrives in ponds if there be sufficient depth of water. It is the type of a particular subgenus of the Carp family (*Cyprinidæ*), which Cuvier has characterised under the name of *Abramis*.

Breaming. In Nautical language, signifies cleaning the bottom of a vessel by fire. When the vessel is aground, fire being applied to the bottom loosens the pitch, or composition of sulphur and tallow, with which the bottom is sometimes covered to defend it from the worms, and which is then scraped off, together with the barnacles, grass, weeds, &c., that adhere to it.

Breast Plough. A kind of spade or shovel, with a cross piece at the extremity of the handle, which is applied to the breast, and by which the operator skims off a thin slice of turf from a grassy surface, as if he were ploughing.

Breast Wheel. In Hydraulics, the name given to a water-wheel so placed as to be struck by the stream of water nearly on a level with the axle, the lower quadrant of the circumference on the side opposed to the stream being placed in a *race* or channel concentric with the wheel, through which the water is conducted in its descent from the higher to the lower level, and in falling on the float boards within the channel acts both by its momentum and weight.

Breast-hooks. In Shipbuilding, are strong curved timbers placed parallel to the surface of the water within the bows, for the purpose of strengthening and consolidating the upright timbers.

Breasting. Breasting up a hedge is cutting the face of it on one side, so as to lay bare the principal upright stems of the plants.

Breastplate. [CUIRASS.]

Breastsummer. [BEAM, in Architecture.]

Breastwork. In Fortification, a hastily constructed parapet, generally without a banquette.

Breathing. [RESPIRATION.]

Breccia (Ital.). A collection of angular fragments of any hard rock cemented into a compact mass, either by carbonate of lime or other cementing medium. Rounded fragments under similar circumstances make *conglomerate* or *puddingstone.* They have the distinctive quality of showing no trace of magnesia, but are capable of taking a fine polish.

Brecciated Agate. Is a variety of Agate composed of fragments of Jasper, Bloodstone, Carnelian, &c., cemented together by Chalcedony.

Breech of a Gun. The solid part behind the bore.

Breech Loader. A term applied to a cannon or smaller firearm which is loaded by the insertion of the charge at the breech instead of at the muzzle. The earliest cannon made in Europe were breech-loaders, having the charge inserted in iron cylinders, which were fixed in their place in the breech of the gun by a wedge. Specimens of these ancient breech-loaders may be seen in the Rotunda at Woolwich. Breech-loaders have now almost entirely superseded muzzle-loaders for sporting purposes; and a committee has just recommended that the whole British army shall be furnished with them. Their chief advantages are rapidity and safety in loading, and facility in examining and cleaning.

All the rifled cannon of less than 6·3 inches calibre in our service are breech-loaders; but no plan of breech-loading as yet tried has been found sufficiently safe for heavy guns fired with large charges. The navy especially object to this system for large guns, alleging that the men are afraid of it, and that it causes too much smoke between decks.

In the Armstrong rifled gun for land service, the breech is closed by a vent-piece or block of iron or steel, which is dropped into a slot behind the charge, and is then screwed tightly up into its proper place.

Breeching or **Breech Band.** Part of the harness of a carriage horse, by means of which he is enabled to push the carriage to which he is attached backwards, or to support its pressure in going down a hill.

Breeching Loop. A loop of metal at the breech end of naval guns, through which a rope called the *breeching* is passed and secured to the sides of the vessel, to prevent the guns recoiling too far, or rolling across the ship in a seaway.

Breeding in and in. The system of close-breeding, which has been applied with much success in the rearing of cattle and race-horses, is sometimes thus designated. (See Nicholas Hankey Smith, *Observations on Breeding for the Turf*, and *Westminster Review* for July 1863, p. 98 &c.)

Breeze (Fr. bris, débris: Wedgwood). The larger refuse arising from passing cinders through a sieve; they are much employed by brickmakers for the purpose of calcining their bricks, and for mixture with the clay when it is too fat for ordinary purposes.

Breeze-flies. [ŒSTRIDÆ.]

Brehon Laws. The ancient laws of the Irish are so termed, from an Irish word signifying *judges.* It is supposed that some of the written collections of these laws which still exist are of great antiquity; as old, perhaps, as the earlier ages of the Christian era. Prior to the Anglo-Norman invasion, Ireland was governed by these laws. (Lord Lyttelton's *Henry II.* vol. v. p. 28, and the authorities there referred to; Goldwin Smith, *Irish History and Character.*)

Breislakite. A variety of Augite occurring, in wool-like flexible fibres, of a chestnut-brown colour, at Capo di Bove, in cavities of the older lavas of Vesuvius. It was named after the Italian geologist Breislak.

Breithauptite or **Antimonial Nickel.** This mineral, a native antimonide of nickel, was formerly found in the Andreasberg mountains, and is now met with in the Pyrenees, especially in the neighbourhood of the Pic du Midi d'Ossola. It occurs in thin hexagonal plates, of a light copper-red colour inclining to violet when newly fractured; also arborescent and disseminated: and it has been observed in a crystallised form among the products of blast-furnaces. Named after Professor Breithaupt, of Freiberg.

Bremer Green. A pigment composed of carbonate of copper, carbonate of lime, and alumina.

Brentus. A Fabrician genus of Coleopterous insects, belonging to the Weevil tribe, or *Curculionidæ*; now the type of a family, called *Brentidæ*, including about eight genera and seventy species. These insects are peculiar to hot climates: only one species, the *Brentus Italicus*, is found in Europe, and this has been referred by Germar to a particular sub-genus, *Arrhenodes*, all the other species of which are natives of the New World.

Bressummer. [BEAM.]

Bretticos or **Brattices.** In coal mines, wooden plankings to prevent the falling in of the strata.

Bretwalda. In English History, the title of an office which conferred a certain supremacy on one of the Anglo-Saxon princes. The need of a common chief over all the Germanic provinces of Britain arose from the great number of independent chieftains, which was only in course of time reduced within the compass of the 'Heptarchy.' The common warfare against the British tribes could scarcely be carried on without a dictator: and this office was naturally conferred on the most powerful chief, or on the prince whose land was most exposed to hostile inroads. The appointment was determined probably by the choice not only of the other kings, but of the

collective nobility and ealdormen. According to Bede, the first chieftain who held this office after Ælle was Ceawlin, the grandson of Cerdic. (Lappenberg, *History of England under the Anglo-Saxon Kings.*)

Breunnerite. A native carbonate of magnesia and iron. It generally occurs crystallised in detached, embedded rhombohedrons in chlorite-slate and Serpentine; sometimes, though rarely, in Gypsum. The only British locality where it has been met with is Unst, in Shetland; the principal foreign localities are St. Gothard, the Tyrol and Norway.

Named after Count Breunner.

Breve (Ital.). In Music, a note formed thus ⊏⊐ without a tail, and equivalent to two semibreves or four minims. Music marked with the words *Alla Breve*, or with the prefix 𝄵, has, properly, one breve in each bar, although the bars may be cut in two for facility of reading.

Brevet. In the French, this term signifies a royal act in writing, conferring some privilege or distinction, as brevet d'invention, a patent. It is applied in England to a commission giving army rank, as distinct from regimental rank. Brevet rank is attained either by distinguished service or by seniority in the army.

Breviary (Lat. breviarium). A book containing the offices of daily prayer according to the usage of the Roman Catholic church. The offices are seven; viz. matins, lauds, prime, tierce, nones, vespers, and compline. Anciently all Catholics were required to recite the breviary daily. The injunction is now confined to the clergy; of whom it is still strictly exacted.

Brevicite. The name given to the better crystallised variety of Bergmannite which occurs in transparent colourless prisms, and in white radiated masses, at Brevig in Norway.

Brevier. In Printing, the name of a kind of small type, the size of that used in this work. [Type.]

Brevipennates, Brevipennes (Lat. brevis, *short*; penna, *quill*; *short-quilled*). An epithet applied by Cuvier to distinguish the first family of his order *Grallæ* (Échassiers); the ostrich is the type of this family. [Cursores.]

Brewing. [Fermentation.]

Brewsterite. A hydrated silicate of alumina, strontia, baryta, and lime, named after Sir David Brewster. It occurs in small grey or yellow transparent crystals, at Strontian in Argyleshire; at the Giant's Causeway, lining cavities in amygdaloidal rocks; also in France, and in the Pyrenees.

Brewstoline. A transparent colourless fluid detected in Siberian Amethyst by Sir David Brewster, after whom it was named. It also occurs in minute cavities in crystals of Topaz, Chrysoberyl, Quartz from Quebec, and in the blue Topaz of Aberdeenshire.

Brexiaceæ (Brexia, one of the genera). A small group of perigynous Exogens sometimes erected into a natural order of the Saxifragal alliance. They are not, however, very closely connected by any well-marked character.

Brianchon's Theorem. In Conic Sections, is the reciprocal of *Pascal's theorem*, and was first given by its discoverer, Brianchon, in the *Journal de l'École Polytechnique*, cah. 13. It is thus enunciated: 'The three diagonals of every hexagon circumscribed to a conic meet in a point,' and may be easily deduced from the anharmonic properties of conics. By allowing two or more sides to coincide, numerous useful corollaries may be deduced.

Bribery (Nor. Fr. bribe [de pain], *a piece of bread*, hence a sop to stop the mouth: Wedgwood). In English Law, is a term comprehending the offences of judges, ministerial officers, &c., receiving rewards or considerations to act contrary to their respective duties, which are severally misdemeanours at common law, and also punishable under several statutes. But in its most ordinary signification, it is the giving or receiving money to procure votes at parliamentary elections, or elections to public offices of trust. The statutes which at present chiefly regulate the offence of bribery at parliamentary elections are 2 Geo. II. c. 24, 49 Geo. III. c. 118, 5 & 6 Vict. c. 102, 17 & 18 Vict. c. 102, the latter continued and amended by subsequent statutes down to 22 & 23 Vict. c. 48. A penalty of 1,000*l.* is imposed on anyone (with incapacity to serve for the place in parliament if returned) who 'shall give or cause to be given, directly or indirectly, any sum of money, &c., upon any engagement that the person receiving shall procure, &c., the return of any member,' and a fine of 800*l.* on the person receiving the bribe on such a promise or agreement. It is an offence in any person 'to procure or corrupt another to vote;' and it has been recently held, that the corruption is complete, as far as the corruptor is concerned, by the act of giving the money, whether the voter intend or not to act according to the wish of the briber. Since the Act 4 & 5 Vict. c. 57, proof of bribery before a select committee renders an election void, although agency for the member be not proved.

Brick (A.-Sax. brice, *a fragment*: Wedgwood). A piece of clay earth, sometimes mixed with coal ashes, chalk, and other substances, formed into a mould, and burnt in a kiln, or clamp, is called in Architecture a brick. The earth used for this purpose is of two sorts; the one a stiff clay, with little or no extraneous matter, which produces a hard red brick; the other a yellowish clay which is very fat, and is called loam, and which requires to be tempered with sand, or breeze (a light kind of ash), to produce a grey-coloured brick. The earth is usually dug some time, and exposed to the action of the atmosphere, and it is mixed with the sand, or breeze, in a pugmill, care being taken to introduce as little water as possible. In moulding the bricks, which is usually done by hand (though of late machinery has been applied to this purpose), it is calculated that

a good workman will turn out as many as 5,000 bricks in a day of fifteen hours; the bricks are then allowed to dry by being exposed on the hacks, and from them they are carried to the kiln, or the clamp. Kiln-burnt bricks are usually more regular in their shape than clamp-burnt ones, and they are produced with a considerable economy in the fuel; but they require more space and more time than the clamp-burnt bricks, and therefore in London and in places where time is an important element of the process of manufacture, the kiln-burnt bricks are but seldom used. When, however, they are resorted to, the kilns are usually made about 13 ft. long, by 10 ft. 6 in. wide, and 12 feet high, and are provided with a regular furnace; when clamp-burnt bricks are used, the *clamp* is formed of the unburnt bricks themselves, generally oblong in plan, and the foundations are laid in *place* (or in previously made underburnt bricks). Each course of bricks is laid on a layer of breeze, or cinders; and flues are formed through the mass of the bricks which are filled with firewood, clay, or breeze; the outer wall of the structure is cased with place bricks, and the draught is regulated by closing the apertures with hurdles covered with clay; the burning may continue from twenty to thirty days. Until within a few years the whole of the produce of the brick yard was subject to an excise, and the dimensions of the bricks were made $8\frac{1}{2}$ inches long, $4\frac{1}{2}$ in width, and $2\frac{3}{4}$ in thickness; but at the present day there is no limitation to their dimensions.

The different varieties of bricks known in trade are the *malms*, or *facing bricks*, which are of a yellowish uniform colour and texture (the white, or the *Suffolk bricks*, are a variety of these); the *seconds*, not quite so uniform in colour and texture as malms; *red and grey stocks*, the former being burnt in kilns, the latter in clamps, both of them inferior to the quality of malms; *place bricks*, sometimes called *sandel* or *samel* bricks, which were those furthest from the fire in the kiln, and therefore the least burnt —these should never be used in a building where durability is an object of importance; *burrs* or *clinkers*, which are masses of several bricks run together in the clamp, or kiln, from the violent action of the fire; *shuffs*, or the broken unburnt particles of the bricks. They make at present a kind of fire-brick $8\frac{1}{2}$ in. × $2\frac{3}{4}$ in. × $4\frac{1}{2}$ in. of the blue Staffordshire clay: and some very beautiful goods are manufactured from the clays of the blue lias formation at Rugby, Ardsey, and at various other places. *Paving bricks* are made for the purpose for which they are named; *compass bricks* are circular on plan, used chiefly in walling or *steining* wells, or such works; moulded bricks are made to any shape which may be required; *Willoughby's clinkers* and *Dutch* or *Flemish* clinkers are chiefly used in stables, the Dutch clinker being 6 in. × 3 in. × 1 in. *Fire bricks, tiles, and retorts* are made of every size and of every form to resist the action of the intense heat of the furnace; they are made of a kind of clay that contains more silica in combination with the alumina than is the case with ordinary bricks.

Brick Clay. A common variety of clay adapted to the making of bricks. Many mixtures and combinations of silicate of alumina with silica, iron, and alkaline earths are available; but the best kinds contain little of the latter materials, as they are apt to cause the bricks to melt and run together into a kind of glass in the kiln. There is no special geological age for brick clays, as they belong indifferently to the oldest and newest formations. The red colour of bricks is derived from the oxide of iron that most clays contain.

Brick Nogging. In Architecture, the brickwork carried up and filled in between timber framing.

Brick Trimmer. A brick arch abutting against the wooden trimmer in front of a fireplace, to guard against fire.

Bricklaying. The art of building in bricks, which is of the remotest antiquity; Pausanias mentions many buildings in Greece thus constructed, and in Rome such buildings were very common. The walls of Babylon, Nineveh and Persepolis, and some of the pyramids of Egypt, were also of brick.

Bricole. [BILLIARDS.]

Bridewell. A house of correction for offenders is commonly so called in England. The name is derived from the ancient London house of correction, originally a hospital founded by Edward VI. on the site of St. Bride's well, in Black Friars, a well-known object of pilgrimage in Roman Catholic times. The original Bridewell is under the control of the Lord Mayor, and used as a receptacle for vagrants, &c., within the jurisdiction of the City.

Bridge (A.-Sax. brycg). In Architecture, the expression is used to designate the structure for the purpose of connecting the opposite sides of a river, gorge, or valley, &c., by means of certain materials, forming a roadway from one side to the other, or occasionally carrying the waterway of a canal, in which case it would be specifically called Aqueduct. It may be of stone, brick, iron (cast or wrought), timber, or suspended from chains; or the roadway may be carried by means of boats, according to the wants and the resources of the position where the bridge is required.

In tracing the history of bridges amongst different nations, it is easy to discover that local causes had great influence on the style of construction adopted in them. A nation may have attained the highest point of art in its other buildings, and nevertheless may have left nothing worthy of our admiration in the nature of a bridge. In Egypt, for example, intersected as it is by a large and wide river subject to periodical inundations, the construction of bridges would have been as difficult as it would have been useless before the introduction of railroads. All the intercourse which commerce required was easily carried on by the assistance of boats; and as regards the passage of the canals with which the country abounded,

their depth and breadth were so small as to require none but the most simple expedients for connecting their opposite banks, nor any which involved the employment of scientific construction. In Greece no vestige of a bridge occurs before its occupation by the Romans; but this, had the Greeks even been acquainted with the use of the arch, might be accounted for by reasons which were substantially the same as those which applied in Egypt. The country is, in fact, intersected by no river of magnitude, and even those which seem entitled to the name are rather mountain torrents, than those immense sheets of water, swelled in their course by innumerable streams, that are to be found in other countries. In this case, nothing more would be required than a single arch, whose abutments would be found in the solid rocks which the streams separated.

But when we turn to Italy, we find a country watered by many and deep rivers, and intersected with deep ravines, where bridge architecture became a necessary study, not only for the accommodation of the inhabitants of the cities, but also for the frequent military expeditions of the people who succeeded in impressing their rule upon its provinces. Rome from its commencement must have put into requisition considerable skill in bridge-building across the Tiber, rapid and subject as it was to sudden floods. The earliest bridges here were of timber; such was that which joined the Janiculum to the Mons Aventinus, and was called the Pons Sublicius from the *sublicæ* (stakes) of which it was formed. Without enumerating the bridges of Rome, some of which are still standing to attest the science of their architects, we must mention the Pons Narniensis on the Flaminian Way near Narni and about sixty miles from Rome. It was built by Augustus; and vestiges of it remain to the present day, one arch above 150 feet span and 100 feet high being still entire. But of the works of art of this description, the most wonderful ever executed in the Roman times was the bridge built by Trajan over the Danube. It consisted of twenty piers, 150 feet in height from their foundation, and 170 feet apart; its breadth was sixty feet. This stupendous work was destroyed by Hadrian, the successor of Trajan, under the pretence that it might serve as a passage for the barbarians if they became masters of it; but some writers have said that it was through envy of the fame that attached to its founder. Over the Tagus, in Spain, an ancient Roman bridge is still standing at Alcantara. It consists of 6 arches, the two centre arches being of 100 feet span, and 150 feet above the ordinary water-line; the whole length of the bridge is about 612 feet. Of the temporary bridges of the Romans, the most celebrated was Cæsar's bridge thrown over the Rhine; it had the advantage of fenders on the upper side of the stream, and stood remarkably well.

From the fall of the Roman Empire to the revival of the arts, the history of bridge architecture is rather a blank, with the exception of some mediæval structures and the Moorish works of Spain. It appears from Gauthier, who uses the authority of Agricola of Aix, that when the arts began to revive in Europe an order was founded, under the name of the Frères Pontiers, and that under them was begun in 1176 the bridge at Avignon, of 18 arches and about 3,000 feet in length; this bridge has since been destroyed. In Spain the bridge of Orense, and of Martorel, may be referred to as specimens of the style of bridge-building then adopted; and the old London and the Dresden bridges are also good samples of mediæval bridges. In 1354 a bridge of 3 arches was constructed at Verona, the roadway sloping from the city; the largest of its arches is 159 feet 9 inches span; but a much larger arch was built at Vieille Brioude, in France, over the Allier, in the year 1454, of nearly 184 feet span, almost the greatest span of any stone bridge in existence. Amongst the most celebrated bridges of Italy is that of the Rialto, at Venice, whose span is 98½ feet. It was begun in 1588, and finished in 1591, from the designs of Antonio del Ponte (Sansovino's *Venice*), though by most authors absurdly attributed to M. A. Buonarotti. In this city alone there are no less than 339 bridges; but they are mostly of small span. We must not omit to notice in this place the bridge della Santissima Trinità at Florence, by Amminati, which, as Milizia has truly observed, has not been surpassed since the revival of architecture. It is of 3 arches, the middle one of 96 and the two side ones of 86 feet span, the width of the piers being 26 feet 9 inches; the breadth of the carriage and the foot ways between the parapets is 33 feet. The arches are portions of a very flat ellipsis; the springing is in a line with the pier and the rise in the centre not much more than ⅐ of the chord; the arches, in fact, are after the fashion of the Tudor arches in this country, the point at the summit, which is extremely obtuse, being hidden by the rams' heads sculptured upon the key-stones. During the last two centuries the French have advanced their bridge architecture to a great degree of excellence, but more particularly so in the latter end of the last century, in which appeared Perronet, the father of the modern system of the art, whose elegant designs have not since been improved upon either in France or in any other country. The beautiful bridge over the Seine at Neuilly is by him; it consists of five arches, each of 128 feet span and 32 feet rise; it was finished in 1774, and remains a splendid monument of the powers of its designer. Some of the more modern specimens of their bridges do great honour to the French school, for their union of beauty of form with sound engineering.

In England the progress of bridge-building has kept pace with that of the Continent, although latterly the engineers appear to have striven in the race for ugliness; but if our bridges cannot boast the elegance of design of

the French or the Germans, they can at any rate lay claim to great merit of boldness in conception and execution. The most celebrated work of the beginning of the last century is the bridge over the river Taffe, near Llantrissant, in Glamorganshire, the work of a country mason, William Edwards; it is 140 feet span with a versed sine of 35 feet, and was erected in 1755. Subsequently Smeaton, Brindley, Jessop, Mylne, Rennie, and Telford executed the bridges connected with their names, and these were followed by the Stephensons, Brunels, Locke, Bidder, Hawkshaw, Tierney Clarke, Fowler and others. We may mention as the productions of the earlier school, the bridges of Hexham, Dumballock, Dunkeld, Stoneleigh, Kelso, Earn, Waterloo, London, Southwark, Limerick, Chester, Carlisle, &c.; and, of the later, we may refer to the High Level and the Menai and Conway plate bridges, the Saltash, the Stockport, Malaunay, and Barentin viaducts, Trent, Victoria, and other bridges; all of which display a profound acquaintance with the laws of bridge-building. The dimensions of the Menai Bridge, of the Chester and Holyhead Railway, and of the Saltash Bridge, in fact, surpass any of those yet attempted; they are, for the first, 459 feet span in the two central openings and 230 feet at the sides; for the second, 433 feet 8 inches in the arches over the navigable part of the river. Evidently some new principles of construction had to be introduced before such gigantic operations were undertaken, and therefore it is that wrought iron was employed. Some idea may be formed of the care and pains taken by Mr. Stephenson in working out the problem of this application of a new material, from a perusal of Mr. Clark's book on the Britannia and Conway Tubular Bridges.

Of timber bridges, the boldest and most ingeniously constructed in Europe was that at Schaffhausen, in Switzerland, destroyed by the French in 1799. It was designed and executed by Ulric Grubenman, a village carpenter of Teuffen, in 1758. The total length of the bridge was 364 feet; but it was relieved by a pier in the middle of the river. In America there are some extraordinary specimens of timber-bridge building. Such is the Trenton bridge over the Delaware, built in 1804 by Burr: its chord line is 200 feet and its versed sine 32 feet, the height or thickness of the timber framing at the crown being only 32 inches. The bridge called Colossus, over the Skuylkill, is 340 feet span, with a versed sine or rise of only 20 feet, and the thickness of the timber at the vertex is only 7 feet; it was the work of a person named Wernwag. Besides these two, there are numerous other timber bridges in America worthy the notice of the reader, such as the bridges built upon the systems of Fowey, Howe, Brown, McCallum, &c.

We shall close this portion of our subject by a reference to the suspension bridges which were so much the fashion some years ago, though at the present day there is rather a prejudice against them owing to the failure of many such structures. Still, the successful resistance of the Menai, the Hammersmith, the Kiel, and the Pesth bridges proves that when properly designed this style of bridge is admirably adapted to a country which is not able to embark large capitals in executing such works; and they also induce us to believe that the cause of the failures is to be sought in the mode of employing the chains, especially when the iron wire has been substituted for them. In suspension bridges the most trying circumstance under which they can be placed is when a long file of infantry is passing over them in military time; the effect of the heavy regular tread of the soldiers is to produce the same result which isochronous impulses recurring constantly upon a pendulum would do. Suspension bridges have been raised by semi-barbarous nations; Mungo Park found a rude adaptation of them in the heart of Africa; and Don Antonio da Ulloa found them applied in the Cordilleras for the communications between the interior and the coast.

In the building of bridges, where piers are required in the midst of the stream for the support of the arches, it is important to place them as nearly as possible at right angles to the stream or current, and the piers should present to the latter the form of an equiangular spherical triangle (of about 60 degrees) in order the better to resist its force. The position of a bridge should not, moreover, be in a narrow part, nor one liable to swell with tides, or floods, inasmuch as the contraction of the waterway increases the depth and the velocity of the current, and may thus endanger the safety of the navigation, as well as that of the bridge itself. It is usual to construct bridges with an uneven number of arches; and this for several reasons, amongst which are the following: that the stream being usually most powerful in the middle, an egress through that part is better provided by having a central opening; and again, if the bridge be not perfectly horizontal, symmetry is gained by rising from the sides to the centre, and the whole roadway may be made of one continuous curve. When a bridge is horizontal throughout its length, much saving will take place in the centring, because two sets will suffice; if, however, the bridge be higher at the extremities than in the middle, the arches on each side of the middle one must decrease in dimension regularly, so as to be as nearly symmetrical as possible, and by this arrangement beauty is gained and the expense of centring is diminished, as the centres of one side will serve for the other. It is, however, to be observed in this matter, that the effect of a long row of flat elliptical arches, such as are now used in bridge-building, is to cause the horizontal line of the road to appear to deflect; and as an æsthetical principle it may be affirmed that all bridges gain by being made to rise in the middle.

It is desirable to construct a bridge with as few arches as circumstances will admit of, as well for the passage of the water in a river, as

for the passage of the boats that may pass up and down, not to mention the economy of labour in the fewer piers resulting from the small number of supports. When the river can be spanned by a single arch, no more should be allowed. The piers should be of sufficient solidity to resist the thrust, or push, of one arch independent of the other arches, so that the centring may be struck without danger of overturning the pier left unprotected (this principle has, however, been neglected in some recent examples, and the Pont St. Maxence by Perronet, and the Barentin Viaduct by Mr. Locke, may be cited as illustrations); and the piers should also be spread as much as possible on their base, and diminish gradually upwards. The method of laying the foundations in a river is usually by means of a cofferdam, which is a large enclosure, made by piling, round the space to be occupied by the pier, so as to render it water-tight, and then by pumping out the water, and keeping the space dry till the pier is built up to the ordinary level of the water. But where the bed of the river is loose, or when the expense of foundations is an object, the present style of executing them is by means of tubes which are brought over the spot they are intended to occupy, and the earth from the inside of them is removed by some of the processes described in a pamphlet by Coulomb and by Mr. Hughes, who superintended the works at Rochester Bridge. When the pile tubes are thus driven to the depth required, they are filled with concrete up to the water's edge. Occasionally the method of founding by caissons may be resorted to; but it is now so well known to be atterded with danger that it is rarely employed. In constructing the centres great care must be taken to make them incapable of bending, or swerving, while the arch is being turned, otherwise it will be crippled; and care must be taken that the centres should be so treated as to be easily removed on the completion.

We here subjoin a table of some of the most important bridges in Europe and America, chiefly in reference to their span and the height of their arches; the reader who may desire more information on the subject is referred to Gauthey's treatise *Sur la Construction des Ponts*; Reibel's edition of Sganzin's *Cours de Construction*; Michel Chevalier's work *Sur les Travaux Publics de l'Amérique*; Weale's *Bridges*; Henz's *Das Eisenbahnwesen in Nord Amerika*; Fairbairn and Edwin Clark's works *On the Britannia and Conway Tubular Bridges*; Navier, *Sur les Ponts Suspendus*; &c. &c.

IRON BRIDGES (CAST).

Name	River	Place	Widest Arch				Curve	Architect	Date
			Span		Rise				
			Ft.	In.	Ft.	In.			
Southwark	Thames	London	240	0	24	0	Segment	Rennie	1818
Sunderland	Wear	Sunderland	240	0	30	0	Segment	Wilson	1796
Buildwas	Severn	Buildwas	150	0	27	0	Segment	Telford	1816
Tarascon	Rhône	Tarascon	204	4	16	6	Segment	Unknown	1859
Nevers	Loire	Nevers	187	9	15	0	Segment	Unknown	1860
Rochester	Medway	Rochester	170	0	17	0	Segment	Cubitt	1854
St. Petersburg	Neva	St. Petersburg	150	0	13	8	Segment	Unknown	—
High Level	Tyne	Newcastle	136	10			Dble. road	Stephenson	1841

IRON BRIDGES (WROUGHT).

Name	River	Place	Widest Arch				Curve	Architect	Date
			Span		Rise				
			Ft.	In.	Ft.	In.			
Britannia	Sea	Menai Straits	458	3	29	3½	Tubular	Stephenson	1850
Saltash	Hamoaze	Plymouth	433	6	30	6	Tubular	Brunel	1860
Boyne	Foyle	Boyne	250	0	22	6	Lattice	McNeil	1855
Victoria	St. Lawrence	Canada	330	0	31	8	Tubular	Stephenson	1858
Kiel	Rhine	Strasbourg	183	8	19	8	Lattice	Vingner	1861
Cologne	Rhine	Cologne	313	0	31	0	Lattice	Unknown	1862
Dirschau	Vistula	Dirschau	398	0	40	0	Lattice	Unknown	1861

SUSPENSION BRIDGES.

Name	River	Place	Widest Arch				Curve	Architect	Date
			Span		Rise				
			Ft.	In.	Ft.	In.			
Menai	Sea	Menai Straits	570	0	42	0	Deflection	Telford	1820
Fribourg	Valley	Fribourg	880	0	63	0	Deflection	Calley	1830
La Roche Bernard	Vilaine	La Roche Bernard	650	4	50	0	Deflection	Leblanc	1846
Pesth	Danube	Pesth	666	0	45	0	Deflection	T. Clarke	1850
Niagara	St. Lawrence	Niagara	821	4	75	0	Deflection	Roebling	1848

STONE BRIDGES.

Name	River	Place	Widest Arch		Curve	Architect	Date
			Span	Rise			
			Ft. In.	Ft. In.			
Chester	Dee	Chester	200 0	42 0	Segment	Harrisson	1820
Vieille Brioude	Allier	Brioude	183 3	70 3	Segment	Grennier	1454
Ulm	Danube	Ulm	181 2	22 3	Segment	Wiebeking	1806
Castle Vecchio	Adige	Verona	159 10	55 3	Ellipse	Unknown	1354
Lavour	Agout	Lavour	159 10	64 8	Ellipse	Sager	1775
London	Thames	London	152 0	29 6	Ellipse	Rennie	1832
Claix	Drac	Grenoble	150 2	62 3	Segment	Unknown	1611
Pont y Pridd	Taffe	Glamorgan	140 0	35 0	Segment	Edwards	1755
Neuilly	Seine	Near Paris	127 10	31 10	Ellipse	Perronet	1774
Mantes	Seine	Mantes	127 10	38 3	Ellipse	Huppeau	1765
Waterloo	Thames	London	120 0	32 0	Ellipse	Rennie	1816
Tonguelsnd	Dee	Kirkcudbright	118 0	38 0	Segment	Telford	1806
St. Esprit	Rhône	Languedoc	108 7	26 6	Segment	Unknown	1305
Munich	Iser	Munich	102 3	17 0	Segment	Wiebeking	1814
Orleans	Loire	Orleans	106 7	29 0	Ellipse	Huppeau	1760
Sarah	Liffey	Dublin	106 0	22 0	Ellipse	Stevens	1791
Montlion	Durance	Montlion	102 0	25 6	Ellipse	Cormont	1805
Vicenza	Bacchiglione	Vicenza	101 2	29 9	Segment	Unknown	—
Blackfriars	Thames	London	100 0	41 6	Ellipse	Mylne	1771
Rialto	Canal	Venice	96 10	20 7	Segment	Antonio del Ponte	1591
Della Trinità	Arno	Florence	95 5	14 10	Pointed	Amminati	1569
De la Concorde	Seine	Paris	93 9	9 8	Segment	Perronet	1791
Jéna	Seine	Paris	91 6	10 9	Segment	Lamandé	1815
Ponte Sisto	Tiber	Rome	83 4	41 8	Semicircle	Unknown	1474
Ponte Molo	Tiber	Rome	77 3	38 10	Semicircle	Unknown	100 B.C.
St. Maxence	Oise	St. Maxence	76 8	6 3	Segment	Perronet	1784
Pont d'Alma	Seine	Paris	141 0	28 0	Elliptical	De la Gournerie	1857

TIMBER BRIDGES.

Name	River	Place	Widest Arch		Curve	Architect	Date
			Span	Rise			
			Ft. In.	Ft. In.			
Colossus	Skuylkill	Philadelphia	340 0	20 0	Segment	Wernwag	1813
Piscataqua	Piscataqua	North America	250 0	27 4	Segment	Palmer	1794
Bamberg	Regnitz	Germany	208 0	17 4	Segment	Wiebeking	1809
Trenton	Delaware	Pennsylvania	200 0	32 0	Segment	Burr	1804
Writtenghen	Rhine	Switzerland	198 0	30 10	Segment	Grubenman	1777
Pont Louis	Iser	Freysingen	154 0	13 6	Segment	Wiebeking	1809
Freysingen	Iser	Bavaria	153 0	11 6	Segment	Wiebeking	1808
Elsinghen	Wertach	Near Elsinghen	139 0	7 8	Segment	Wiebeking	1809
Lech	Wertach	Near Augsburg	114 0	8 9	Segment	Wiebeking	1808
Peacock's Falls	———	North America	136 6	17 0	Lattice	Unknown	about 1838
Ellicott's Mills	———	North America	150 0	20 0	Side truss	Unknown	about 1838

Bridge. In a steamship, is the platform raised above the deck for the purpose of connecting the paddleboxes. It forms a post of observation from which the captain has an excellent view of the vessel's course.

Bridges, Military. Temporary bridges are usually made with piles, trestles, boats, pontoons, or casks.

Pile bridges are applicable for rapid, shallow, and muddy rivers, where boats cannot be used.

Trestle bridges are easily made, and answer the same purpose.

Boat bridges are made by mooring boats alongside each other across a river, and laying trestles across them.

Pontoon bridges are generally used, as an army can carry pontoons about; where, however, they are absent, casks may be used as substitutes.

Bridgewater Treatises. In Scientific History, a series of works published in accordance with the will of the Rev. Francis Henry, earl of Bridgewater, who died in 1829. Eight thousand pounds were vested in trustees, and placed at the disposal of the President of the Royal Society, Davies Gilbert, who appointed eight gentlemen to write treatises on subjects illustrative of the 'power, wisdom, and goodness of God, as manifested in the Creation.' The works are: 1. By the Rev. T. Chalmers, D.D., *The Adaptation of External Nature to the Moral and Intellectual Constitution of Man.* 2. By John Kidd, M.D., *The Adaptation of External Nature to the Physical Condition of Man.* 3. By the Rev. W. Whewell, *Astronomy and General Physics, considered with Reference to Natural Theology.* 4. By Sir Charles Bell, *The Hand, its Mechanism and Vital Endowments, as evincing Design.* 5. By Peter Mark Roget, M.D., *Animal and Vegetable Physiology, considered with Reference to Natural Theology.* 6. By the Rev. Dr. Buckland, *On Geology and Mineralogy.* 7. By the Rev. W. Kirby, *On the*

History, Habits, and Instincts of Animals. 8. By William Prout, M.D., *Chemistry, Meteorology, and the Function of Digestion, considered with Reference to Natural Theology.*

Bridging Joist. [JOIST.]

Bridles. On Shipboard, are short ropes serving to connect various portions of the base of a sail with the bowline, which otherwise only draws upon the corner of the sail.

Brief (Lat. brevis, *short*; Nor. Fr. bref). A word applied originally to a small written scroll; but it is used at present in several significations.

1. In Ecclesiastical Law, letters addressed from the pope to temporal princes or communities on subjects of discipline or public affairs are termed Apostolical Briefs. The name appears to have arisen from the difference of size between this smaller kind of instrument and the ample bullæ (bulls) of the popes. Apostolical briefs are usually written upon paper, though sometimes parchment is used. They are sealed in red wax with the seal of the Fisherman (sub annulo Piscatoris), which represents St. Peter casting a net into the sea. (Ciampini, *Dissertatio de Abbrev. Munere*, cap. iii.)

2. In Law, the term Brief is applied to an abridged narration of the facts of a case prepared for trial, with or without a reference to points of law involved in it, drawn up for the preliminary instruction of an advocate.

3. The term Brief is applied in England to king's letters, issued to the archbishops, bishops, clergy, magistrates, and parochial officers, to authorise collections of money at the doors of the several churches and chapels throughout the country, in individual cases wherein application has been made for such assistance towards the building or repair of a particular church. This custom is supposed to have commenced after the disuse of papal briefs consequent on the Reformation; but of late years it has been dropped.

Brig (perhaps an abbreviation of brigantine). The general term for a vessel having two masts, with a boom mainsail, being otherwise square-rigged; that is, having her sails brought to yards hung horizontally by the middle.

Brigade (Ital. brigata, *a company*). This term implies either the union of two or more regiments or battalions of infantry or cavalry, or both together, either with or without artillery, under one command. In the artillery batteries are combined into brigades, as companies of infantry are into battalions. In the expedition to the Crimea in 1855, each infantry brigade was formed of three battalions. The commander of a brigade is called a brigadier-general.

Brigandine. A kind of scale-armour, worn by the light troops called *Brigands*—a name used during the middle ages in the sense of skirmishers, from Low Latin briga, *strife*. (Wedgwood, *Dictionary of English Etymology*.)

Brigantine (Span. bergantin). A name often applied to a small brig of a foreign nation. The older English form is brigandine.

Briggs' Logarithms. The common or vulgar system of logarithms constructed on the base 10 is sometimes called Briggs' system, after their constructor Henry Briggs, a contemporary of Lord Napier, who discovered logarithms in the early part of the seventeenth century. [LOGARITHMS.]

Bright (A.-Sax. beorht; briht). In Painting, shining with light; a term applied to a picture in which the lights preponderate over the shadows.

Brillante (Ital.). In Music, prefixed to a movement, denotes that it is to be played in a gay and lively, or brilliant, manner.

Brimstone (A.-Sax. bren, *to burn*). A commercial name for refined sulphur. [SULPHUR.]

Bringing-to. Is the act of stopping the course of a ship through the water, so that she becomes nearly stationary. This is effected by brailing up the sails, or by so setting them as to counteract each other. The operation of bringing-to in a strong wind can rarely be performed without passing over a considerable space.

Bristol Diamonds, Bristol Stones. Small and brilliant crystals of colourless Quartz found in the Mountain Limestone of the vicinity of Bristol. They are occasionally used, in a cut and polished state, for ornamental purposes.

Britannia Metal. An alloy of tin with a little copper and antimony.

British Gum. When starch is exposed to a temperature of about 600° it becomes of a brownish colour, and so far altered in its chemical characters as no longer to form a blue colour with iodine; it is also soluble in cold water. In this state it is used, under the above name, by calico printers.

Broaching-to. In Sailing, is to allow the ship's head to incline rapidly to windward of her proper course. This is occasioned by negligence, and may result in the sails being taken aback and the dismasting of the vessel.

Broad Arrow. A cuneiform mark, placed on all stores and material belonging to the British Admiralty. It is unknown when this mark originated; but a penalty was affixed in 1698 to the use of it by any private person under the Act 9 and 10 Wm. III. cap. 41.

Broadcast. In Horticulture and Agriculture, is a method of sowing seeds by casting them or scattering them abroad, so as to distribute them evenly over the entire surface of the soil, in opposition to sowing in drills or rows. The operation of sowing broadcast is generally performed by the hand, the operator carrying the seeds in a bag or sowing sheet, or in a basket. There are also machines for sowing broadcast, but they are not much in use. In general, grasses are sown broadcast, while corn, pulse, and broad-leaved plants grown for their roots or leaves are sown in drills or rows. The term is sometimes applied to planting, but it is more generally restricted to sowing.

Broadside. In Printing, any large page printed on one side of a sheet of paper. Modern broadsides are of various sizes, sometimes consisting of several sheets, which, when put together, frequently cover a great space. The letters used in the largest are often two or three feet in length, each one occupying a whole sheet. Old English broadsides are frequently valuable as illustrating the history of the period.

Brochantite. A native sulphate of copper has been thus named after Brochant the French mineralogist.

Broken-backed. A ship is said to be broken-backed when, in consequence of being loosened from age or injury, her frame droops at either end.

Broken-winded. A ruptured state of the air-cells, chiefly on the edges of the lungs, in the horse, in consequence of which the expiration occupies more time than the inspiration of the air, and is laboriously and generally spasmodically effected. It is a disease which may admit of palliation, but not of cure; the animal becomes gradually less capable of exertion, and if urged on, he drops and dies.

Broker (a word of doubtful origin). In Mercantile Law, a person employed in contracting for the disposal of property without being put in actual possession of it, as is the case with a factor. [FACTOR.] But all agents answering to this definition are not brokers, nor has the term any very exact legal signification. Particular classes of brokers are: bill or exchange brokers, stock brokers, insurance brokers, pawnbrokers, and brokers who sell or appraise household furniture for rent. By 8 & 9 Wm. III. c. 20, brokers in the city of London must be licensed by the mayor and aldermen, and grant a bond with a penalty of 500*l.* on their admission. According to mercantile usage, if goods within the city of London are sold by a broker to be paid for by a bill of exchange, the vendor, if not satisfied with the solvency of the purchaser, has a right within a reasonable time to annul the contract.

Brokerage. The percentage paid to the broker for his trouble in effecting a sale, or in negotiating any particular business.

Bromal. An organic compound consisting of *Aldehyde* in which three equivalents of hydrogen are replaced by chlorine. It is an oily liquid of unpleasant odour.

Bromargyrite. Native bromide of silver. [BROMYRITE.]

Bromeliaceae (Bromelia, one of the genera). A natural order of Endogenous plants inhabiting the tropical parts of the world, where they grow in the rich vegetable soil of forests, or upon the branches of trees, to which they cling by their twisting slender roots. They usually have hard leaves, which are covered with a scurfiness easily rubbed off, and are so arranged as to be able to hold the water that lodges in their centre. Many of them will grow for months, and flower, when suspended in the air, after being severed from their roots. Their flowers are usually white, crimson, blue, or purple, and often exceedingly handsome. In the genus *Ananassa* the bracts and flowers are so fleshy, that they all grow together into a solid mass, and thus form the well-known fruit called the Pine-apple. *Tillandsia usneoides* is a curious species of this order, hanging down in long grey threads from the branches of trees in American forests, and so seldom flowering that it might be taken for some species of lichen; it is easily dried, and then used for stuffing mattresses, &c. *Bromelia Pinguis* is a remedy against worms, and yields a cooling fever drink; and other species of *Bromelia* supply valuable fibre for textile purposes.

Bromine (Gr. βρῶμος, *a strong odour*). An undecompounded substance discovered in 1826 by M. Balard of Montpellier. In its general chemical habitudes it much resembles chlorine and iodine, and is often associated with them. It exists, but in very minute quantities, in sea-water, and in the ashes of marine plants. It is usually extracted from *bittern* by the agency of chlorine. At common temperatures it is a very dark reddish brown liquid, of a powerful and suffocating odour, and emitting brown vapour. Its specific gravity is about 3. It boils at 116° and congeals at 4°. The density of its vapour is 5·5; 100 cubic inches at mean temperature and pressure weighing 167·25 grains. It is an electro-negative; it has bleaching powers, and is very poisonous. Its equivalent number is about 78: it combines with hydrogen to form *hydrobromic acid gas*, 100 cubic inches of which weigh 84·7 grains. With oxygen it forms the *bromic acid.* Its combinations are termed *bromides*; they have not hitherto been applied to any use, but some of them are probably possessed of powerful medical qualities.

Bromoform. A compound analogous to chloroform, but containing bromine in the place of chlorine. It is a heavy volatile liquid.

Bromyrite. Native bromide of silver. When pure it is of a yellow colour with a slight tinge of green. It is met with at Huelgoet in Brittany; also in Mexico and Chili, accompanying other ores of silver.

Bronchia (Gr.). The smaller ramifications of the windpipe.

Bronchitis (from Gr. βρόγχια). Inflammation of the bronchia.

Bronchocele (Gr. βρόγχος, *the throat*, and κήλη, *a tumour*). A tumour on the fore part of the neck, being a morbid enlargement of the thyroid gland. From its prevalence in Derbyshire, it is sometimes called the *Derbyshire neck*; and it is a very common disease among the inhabitants of mountainous districts, especially of the Alps. It has been attributed to some peculiarity of the water of those districts, but upon no satisfactory evidence. Iodine has been administered successfully in the cure of this and other glandular enlargements.

Bronchotomy (Gr. βρόγχος, and τέμνω, *I cut*). The operation of making an opening into the trachea in order to prevent suffocation.

Brongniardite. A sulphide of antimony, silver, and lead; found in the mines of Mexico with Iron Pyrites, and named after M. Brongniart.

Brongniartine or **Brongniartite.** Native sulphate of soda, and lime. [GLAUBERITE.]

Brontozoum (Gr. βροντή, *thunder*, and ζῶον, *animal*). A genus of the large, apparently cursorial, fossil birds of the triassic deposits in the Connecticut valley has thus been called. It is only known by the gigantic footprints, some of which measure twelve inches between the tips of the inside and outside toes. The average length of stride, as shown by the distance between the impressions, was between three and four feet; the same limb was therefore carried out each step from six to seven feet forward in the ordinary rate of progression.

Bronze (Fr.). Bronze and bell metal are alloys of copper and tin in the proportion of 88 to 92 per cent. of the former, and of 8 to 12 of the latter; small portions of zinc or brass, and also of lead, are occasionally added. These alloys are harder and more fusible, but less malleable, than copper. The specific gravity of bronze exceeds the mean of its component metals when carefully hammered and free from air-blebs; but bronze castings are apt to be porous unless considerable care and skill have been used in fusing and pouring the metal, and in the construction of the mould; and in large castings, owing to the gradual cooling of the mass, there is often a want of uniformity in the composition of different parts of it; that portion containing the least tin being the first to solidify, while the more fusible portion to a certain extent separates, and is sometimes projected from the mould. In large bronze castings, such as statues, porosity and bubbles require carefully to be avoided: where they exist so as to deface the appearance of the work, they are sometimes filled up with substances which are only temporarily durable, or which, if metallic, give rise to electrical effects which time renders prejudicially evident. For this reason, the different pieces of a large statue should be fused together, or united by bronze, and not by a mere fusible solder; and iron bars and leaden junctions, for the support or fixing of the work, should, upon the same principle, be avoided, as they are themselves liable, under such circumstances, to corrosion, and this may affect the stability or safety of the statue, independently of other influences. Of the difficulty of casting a large and perfect bell in bronze, the Great Bell at Westminster has furnished a memorable instance.

Tempering produces upon bronze an effect directly opposite to that upon steel; and in order to render bronze malleable, it must be heated to redness and quenched in water. The alloy which thus acquires the greatest tenacity is that of 8 of copper and 1 of tin, and this is consequently preferable for medals; the advantage of bronze over copper for these purposes being hardness and resistance to oxidation; the former quality resists friction, and the latter has handed down to us the works of the ancients with little deterioration, though buried for ages in damp soil or immersed in water. The small value of bronze, as compared with gold and silver, is also another important consideration, as affecting the preservation of such works of art. The alloy employed in the present bronze coinage is composed of 95 copper, 4 tin, 1 zinc. The pound avoirdupois is coined into 48 pence, each piece weighing 145·83 grains; into 80 halfpence, each weighing 87·50 grains; into 160 farthings, each weighing 43·75 grains.

Bronzing. This term is sometimes applied to the peculiar brown colour imparted to tea-urns, coffee-pots, and similar copper vessels, giving them a more agreeable appearance, and resisting tarnish and discolouration. This is effected by coating them with a film of suboxide of copper: the vessel is first cleaned, and then rubbed over with peroxide of iron (colcothar) made into a paste with a dilute solution of acetate of copper; in this state it is heated in a proper furnace or muffle, till it is found on brushing off the oxide that the surface beneath has acquired its proper hue. Medals may be bronzed in the same way.

Bronzing Liquid. A solution containing chloride of antimony and sulphate of copper, used for bronzing iron gun-barrels. Brass is sometimes bronzed by washing it over with a solution of chloride of platinum.

Bronzite. A variety of Diallage, with a pseudo-metallic lustre, frequently approaching to that of bronze (whence the name). It occurs in masses, with a lamellar structure inclining to fibrous, in the Serpentine of Cornwall; in the Syenite of Glen Tilt in Perthshire; in the Greenstone of the Isle of Skye; at Benenagh in Londonderry; also, in Styria, Piedmont, the Harz, &c.

Brookite. Pure native titanic acid, named after Brooke the crystallographer. It occurs in hair-brown, yellowish, or reddish crystals, which are more or less translucent, and have a brilliant lustre inclining to metallic, near Tremadoc in Caernarvonshire; at Tavistock; and in Perthshire. It has also been found in Dauphiny, Savoy, the Urals, and at the Val del Bove, Etna. The opaque iron-black crystals from Arkansas have been named Arkansite. [ANATASE; ARKANSITE; RUTILE.]

Broom (A.-Sax. brom). The *Sarothamnus scoparius*, *Spartium scoparium*, or *Cytisus scoparius* of botanists, is an evergreen shrub, native of sandy soils throughout Europe. The Broom is sown extensively in this country as a shelter for game, and among the other plants in young plantations as a screen from the wind and a protection till the more important species can establish themselves. Its branches, which are tough, are made up into brooms, to which they have given their name.

Brooming of a Ship. [BREAMING.]

Brora Coal. Oolitic-coal fields are well known in various parts of Europe, Asia and America, and are in many cases valuable and productive. One of the oldest known workable

deposits of this kind was opened at Brora and its neighbourhood, on the north-east coast of Scotland, at the close of the sixteenth century, and is called the 'Brora coal.' Although not sufficiently good to compete with the coals of the regular coal measures, it is still an available fuel.

The Brora coal-field is chiefly interesting as the best of the small number of oolitic deposits of this kind in England. The coal lies with shales and sandstones; but like many of the small coal-basins of all ages, the various beds repose directly on granite without the intervention of other formations. Judging from its fossils, it belongs to the lower part of the oolitic series.

Brosimum (Gr. βρώσιμος, edible). A genus of *Artocarpaceæ*, consisting of South American trees, abounding in milky juice. They have large simple leaves; and the male and female flowers, which sometimes are produced on separate trees, are generally congregated into a globular head. *B. Alicastrum* yields the edible Bread-nuts of Jamaica; *B. Galactodendron* (sometimes called *Galactodendron utile*) is the Cow-tree or Palo de Vaca. The latter is a very tall tree, forming large forests. The milk is obtained by making incisions in the trunk, and so closely resembles that of the cow that it is used as an article of food, being wholesome, agreeable and nourishing.

Broussonetia (named in compliment to Broussonet, a French naturalist). A genus of Morads allied to the common mulberry, one species of which, the Paper Mulberry, *B. papyrifera*, furnishes a fibrous bark much used by the Chinese and Japanese in the manufacture of paper. It is a small tree, with deciduous leaves, of variable shape, mostly ovate, but sometimes divided into from three to four irregular lobes. The Pacific Islanders manufacture many of their garments from the bark of the Paper Mulberry.

Brown (A.-Sax. brun). In Painting, a dark dusky colour inclining towards red, of various degrees of depth, of which there are many sorts. It belongs to the tertiary colours, known as russets and olives, in which the hue is modified by an admixture of dark or black pigment.

Brown Clay Iron-stone. A variety of Brown Iron-ore consisting of anhydrous peroxide of iron with an admixture of argillaceous matter.

Brown Coal. A variety of Coal, distinguished from stone coal by its streak when scratched, which is brown and different from the black streak of coal. There are, however, two distinctions of greater importance than streak, affecting brown coal: one is that they deteriorate by exposure to the air, tending to split and fall to powder; the other, that they contain water, which interferes with their value as economic fuel.

As almost all the lignites belong to a more recent geological period than that called 'carboniferous,' they have been often spoken of as *modern coal*. They are, however, confined to no age, many true lignites occurring in rocks much older than the tertiary period, while some tertiary rocks contain excellent stone coal.

Many of the lignites, or brown coals, so closely approach pit coal in appearance, that it requires an accustomed eye to detect any difference. Exposure to the air, however, soon settles the question, as the brown coal after about six weeks or two months falls into powder, whereas a good coal undergoes hardly any change. Experiments in getting up steam would tell the same story, as a much larger weight of brown coal than of pit coal is needed for the purpose.

The consumption of brown coal in countries where other fuel is scarce, is very large. Nearly 700,000 tons of it are officially reported as having been raised and sold in the Austrian dominions during the year 1861.

Brown coal appears to be more common in the great middle tertiary basins of Europe than elsewhere. It is especially abundant in the basin of the Danube and other deposits connected with the Eastern Alps and Carpathians, where its quality is very excellent. [LIGNITE; BOVEY COAL; KIMERIDGE COAL.]

Brown Iron-ore. A native hydrated peroxide of iron composed of 85·6 per cent. of peroxide of iron and 14·4 water; often with small percentages of silica, alumina, &c.

There are several varieties of this ore, which generally occurs in stalactitic, botryoidal, and mammillated forms, with a fibrous structure, a silky lustre and often a semi-metallic appearance: it is, also, sometimes earthy. [LIMONITE; BOG IRON-ORE; LAKE ORE; YELLOW OCHRE; BROWN AND YELLOW CLAY IRON-STONE; &c.] In colour it is of various shades of brown, and is distinguished from other ores of iron by a brownish yellow streak, free from any tint of red.

Brown Iron-ore is a valuable and abundant ore of iron, and occurs in several countries, diffused through many formations.

Brown Spar. A magnesian carbonate of lime, tinged by oxide of iron and manganese. The name is applied more especially to those varieties of brown crystallised Dolomite which contain carbonate of iron.

Brownists. In Ecclesiastical History, the followers of Robert Brown, who in the year 1581 established a sect upon the principle that every congregation should form a church independent (in matters of discipline and doctrine) of all others. In matters of doctrine he did not himself differ from the church: to which indeed he returned, and in which after some years he took preferment. The Brownists underwent great persecution under Elizabeth, and retired in considerable numbers to Holland. From them, however, have sprung the Congregationalists or Independents, a very powerful sect in England at the present day. [INDEPENDENTS.]

Bruchus. A Linnæan genus of Coleopterous insects, of the tribe *Rhyncophora*, now the type of a family (*Bruchidæ*), with the following characters: upper lip distinct; head

produced anteriorly into a broad flattened snout; palpi filiform; antennæ filiform or serrate; eyes notched; wing-sheaths not covering the extremity of the body. The insects of this family deposit their eggs in the young grains or seeds of leguminous plants; the time of the hatching of the eggs is when the seeds have approached to maturity, and then the larvæ begin to feed voraciously upon them. One species, the *Bruchus granarius*, infests our peas; and the ravages of this insect, and the *Bruchus pisi*, have been so extensive as to call for legislative interference: in France, for example, in the year 1780, the sale of peas in the market was prohibited, in consequence of the damaged and unwholesome condition of those vegetables through the operations of the species of *Bruchidæ* above cited.

Brucia. A vegeto-alkaloid, discovered by Pelletier and Caventou in the bark of the *Brucia antidysenterica*; and also associated in small relative proportion with *strychnia* in the nux vomica and St. Ignatius's bean. It is very bitter and poisonous.

Brucite. The name given by Cleaveland to Chondrodite, in honour of Prof. Bruce of New York, by whom the mineral was first described. The name is, however, commonly applied to native hydrate of magnesia. This salt, which is composed of 68·97 per cent. of magnesia, and 31·03 water (the magnesia being sometimes partly replaced by iron), usually occurs in fibrous or foliated masses. [NEMALITE.] It is white inclining to grey, blue, or green, with a pearly lustre, and is more or less translucent.

The Brucite found, in the Shetlands, forming veins in Serpentine at Swinaness in Unst, occurs in aggregated foliated plates of a silvery-white colour, and translucent. Amongst other localities it is chiefly met with at Pyschminsk in the Ural, Hoboken in New Jersey, Pennsylvania, Texas (*Texalite*), &c.

Bruniaceæ (Brunia, one of the genera). A small family of epigynous Exogens closely related to the *Hamamelidaceæ*, and of botanical interest only.

Brunner's Glands. These glands, so called after their discoverer, are minutely lobulated bodies, situated beneath the mucous membrane in the tissue of the duodenum: they are provided with permanent gland-ducts, which pass through the mucous membrane and open on the internal surface of that intestine.

Brunolic Acid. A brown vitreous substance contained in the distillate of coal tar.

Brunoniaceæ (Brunonia, the only genus). A small family of perigynous Exogens belonging to the Echial alliance, and consisting of an almost solitary species of Australian herb, named after Robert Brown, the eminent English botanist.

Brunswick Green. A pigment obtained by exposing metallic copper to the action of muriate of ammonia. It is a compound of chloride and oxide of copper. It is also generated by the action of sea-water upon copper, as in the green matter which incrusts the copper sheathing of ships.

Brush. In Painting. [PENCIL.]

Brush Ore or **Black Brush.** A local term applied in the Forest of Dean, in Gloucestershire, to a stalactitic Brown Iron-ore found hanging from the roofs of caverns, and also in large quantities in the 'sandstone' and 'limestone vein' of the lower carboniferous rocks of that locality.

Bruta (Lat.). The term by which Linnæus designated an order of Mammals, including the elephant, manati, and walrus, with the quadrupeds now forming the order *Edentata* of Cuvier.

Bryaceæ (Bryum, one of the genera). A natural family of Mosses of the acrocarpous group, distinguished by their capsules having a double row of teeth, the inner of which are united at the base by a common plicate membrane. The name is sometimes applied to all the true Mosses.

Bryonine. A bitter poisonous principle, extracted from the root of the *Bryonia alba*.

Bryony (Gr. βρυώνη). The *Bryonia dioica*, a wild climbing plant belonging to the Cucurbitaceous order. It has a large woody perennial root, and annual stems, which resemble those of a gourd, except that they are more slender, clinging to bushes by means of their twisting tendrils. As its name implies, it is diœcious. The berries are scarlet, with a disagreeable odour when bruised. The leaves have five angular lobes, and are three or four inches broad, with many callous tubercles. The roots are violently purgative.

Bryozoa (Gr. βρύον, *moss*; ζῶον, *animal*). An order of compound polypes, including the *Flustra* or sea-mat, which incrusts foreign bodies like moss. The organisation of the individual polypes resembles that of the Ascidian molluscs.

Bubalus (Lat.; Gr. βούβαλος, a term originally applied to a species of antelope: but afterwards transferred, in the age of Martial, to different species of the ox). A genus of Bovidæ which is formed by the buffaloes of India and Africa (*B. Buffelus*, *B. Arni*, *brachyceros*, and *Caffer*), the musk buffalo of North America (*B. moschatus*), and the anoa (*B. depressicornis*) and *taxicolor*. Fossil evidences of the musk buffalo have been found in pliocene deposits at Maidenhead (Berks). The genus Bubalus includes those species which have the bony core of the horn excavated with large cells or sinuses communicating with the cavity of the nose; the horns are flattened, and bend laterally with a backward direction, and are consequently less applicable for goring than in the Bisons, or Taurine group of oxen; the head is large, with a narrow but convex forehead, and terminates in a broad muzzle. The Buffaloes are of large size, but low in proportion to their bulk; they have no hunch on the back, and only a small dewlap on the breast: the hide is generally black; the tail long and slender. The Buffaloes occupy

the warm and tropical regions of the earth; they avoid hills, and prefer the coarse vegetation of the forest and swampy regions to that of open plains; they love to wallow in water; they swim well, and cross the broadest rivers without hesitation; their gait is heavy, and they run almost always with the nose horizontal, being principally guided by the sense of smell. The Arnee Buffalo (*Bos Arni*) is the species in which the horns attain the greatest size: there is a pair of horns in the British Museum considered by Colonel Smith to be of the true or Great Arnee: each of these horns measures along the curve from base to tip, six feet three inches; circumference at the base, eighteen inches.

Bubo (Gr. *βουβών, the groin*). A tumour very frequently occurring in the glands of the groin, and also in the armpit. It is often the result of local absorption of irritating matter, as in venereal buboes; or is symptomatic of constitutional disease, as in the plague, scrofula, and some fevers.

Bubonocele (Gr. *βουβών, the groin*, and *κήλη, tumour*). A rupture forming a tumour in the groin.

Buccaneers (Fr. boucanier, from boucan, a word of the Carib Indians signifying a place for feasting on meat which was smoked and cooked at the same time; hence those who established themselves on the West India islands for the purpose of smoking meat were called buccaneers: Wedgwood, *Dictionary of English Etymology*). The pirates who infested the coasts of the West Indies and South America during the seventeenth and eighteenth centuries were so called. The association of these pirates is said to have commenced as early as the middle of the sixteenth century; but in 1625 they obtained possession of St. Kitt's, and afterwards of Tobago, which thenceforward became for a long time the head-quarters of the buccaneers, who formed a sort of seafaring republic, composed chiefly of English and French adventurers. Their chief object was war against the Spaniards, and plunder of their ships and settlements. After the peace of Ryswick, in 1697, they gradually disappeared from the seas. The *History of the Buccaneers of America*, by James Burney, is a well-known and entertaining work. By French writers these pirates are commonly called *Flibustiers*, apparently a corruption of the English word *freebooters*.

Buccinator (Lat.). A muscle of the cheek called into action in various motions of the mouth, and especially in blowing a wind instrument.

Buccinum (Lat. *a trumpet* or *shell-fish* so called). The name of a Linnæan genus of Vermes Testacea, characterised by having a shell with a smooth non-plicated columella, and with a fissure or short respiratory canal inflected towards the left. The mollusca with shells corresponding to this character are ranked amongst the Pectinibranchiate Gastropods by Cuvier, and have been subdivided into the following subgenera: *Buccinum* proper, Brug., of which the whelk, *Buc. undatum*, is an example; *Nassa*, Lam.; *Eburna*, Lam.; *Ancillaria*, Lam.; *Dolium*, Lam.; *Perdix*, Mart.; *Harpa*, Lam.; *Purpura*, Brug.; *Monoceros*, Lam.; *Ricinula*, Lam.; *Concholepas*, Lam.; *Cassis*, Brug.; *Morio*, Montf.; *Terebra*, Brug.

Bucco (Lat. bucca, *cheek*). The name of a genus of Zygodactyle birds, called Barbets. The scientific term relates to the tumefaction of the sides of the base of the bill; the trivial English name is derived from the bristly feathers which surround the base of the bill, and project beneath the chin like a beard. The genus is now the type of a family, including the Barbets proper (*Bucco*), the Brazilian barbets (*Tamatia*), and the Barbicans of Buffon, which are limited to the warmer parts of India and Africa.

Bucentaur (Gr. *βοῦς, an ox*; *κένταυρος, a centaur*). A mythological monster, half-man and half-ox, as the Greek etymology of the word imports. This was also the name of the state galley of the Venetian doges, in which they annually sailed over a portion of the Adriatic on Ascension Day, and dropping a ring into the sea, espoused it in the name of the republic, with the words, 'Desponsamus te, mare, in signum veri perpetuique dominii.'

Buceros (Gr. *βουκέρως*, from *βοῦς*, and *κέρας, a horn*). A genus of Syndactylous Insessorial birds, remarkable for the prodigious size of the mandibles, of which the superior in some species supports a large horn-like protuberance. The birds of this genus are commonly called horn-bills; they are peculiar to the Old World, and perform the same offices in wild nature as the tucans of America.

Bucholzite. A variety of Sillimanite (named after the German chemist, Bucholz), of a whitish, greyish, or pale brown colour, with a lustre approaching to adamantine. It is a sesquisilicate of alumina, and is found in fibrous masses, sometimes approaching distinct prisms at Fassa-thal in the Tyrol, at Chester on the Delaware, and at other places in the Northern States of America.

Bucka or **Buchu.** A strong-smelling leaf imported from the Cape of Good Hope, and used medicinally as a tonic in affections of the kidney and bladder. It is produced by *Barycsma* or *Diosma crenata* and some allied species.

Bucking. The washing of linen with weak alkaline leys, in the operation of bleaching.

Bucklandite. A variety of Pistacite (named after Dr. Buckland), bearing much resemblance to Augite. It has been found at Arendal in Norway, in the lavas of the Laacher-See on the Rhine, and at Achmatowsk in Siberia.

Buckwheat (a corruption of beechwheat). A kind of grain, produced by the *Fagopyrum esculentum* of botanists. It has a triangular form, not unlike that of beechmast, but small. In some countries it is cultivated as food for man, and even in this country its flour is said to enter into the composition of the thin cakes called crumpets; but its chief value is as food

for pheasants, which are so fond of it that they may be decoyed from their preserves by its employment. It is said that some estates have been rapidly stocked with this description of game, at the expense of the neighbouring coverts, by the aid of a few fields of buckwheat. It is a good healthy corn, and may be grown on poor light soils. A bushel of seed per acre is sown broadcast in May. The plant was formerly and is now sometimes included in *Polygonum*.

Bucolics. The Greek term for pastoral poems, meaning literally the songs of herdsmen (βούκολοι). To this class belong the poems of Theocritus, Bion, and Moschus, and the Eclogues of Virgil. The metre universally employed is the hexameter or heroic; but in pastoral poetry an easier flow of the lines was studied than in epics, and this was generally accomplished by introducing a larger proportion of the metrical feet called dactyls in the former than in the latter. This species of poetry has been cultivated also by most modern nations, and in England, France, and especially in Germany, with great success.

Buddhism. A religion which prevails over a great part of Asia; and, according to the estimates of some geographers, has a much greater number of worshippers than any other form of faith among mankind. China, the peninsula beyond the Ganges, Japan, Ceylon, and various Indian islands, are chiefly peopled by Buddhists. The founder of this religion, according to tradition, was an Indian prince, to whom the title of Buddha, or 'The Enlightened,' is assigned by his worshippers. The time at which he lived is uncertain. The Brahmans would, of course, pay no attention to his life or death, nor could any reference be made to either for chronological or other purposes till the time of Asoka, who established Buddhism in India in the third century B.C. (Max Müller, *History of Sanskrit Literature*, p. 264 &c.; see also Barthélemi de St. Hilaire, *Le Buddha et sa Religion*.) Buddhism was expelled from India by the persecutions of the Brahmans, between the fifth and seventh centuries of our era. The doctrines of the Buddhists seem mainly to rest on the principle, that the world, and sensible objects contained in it, are manifestations of the Deity, but of a transient and delusive character; that the human soul is an emanation from Deity; that after death it will again be bound to matter, and subjected to the miseries and accidents of this life, unless the individual to whom it belongs succeeds by the attainment of wisdom, through prayer and contemplation, in liberating it from that necessity, and secures its absorption into that divine essence from which it sprang.

Bude Light. This term has been applied to various forms of oil and gas burners contrived by Mr. Gurney, of Bude, in Cornwall. The original proposal was to maintain the combustion by means of a supply of oxygen gas to the burner, by which, with oil or naphthalised gas, an intense light may be commanded, but at an inconvenience and expenditure quite incompatible with its economical adoption. Large gas burners with variously formed reflectors and refractors have since been erected in different parts of London under the name of *Bude Lights*, but they have nothing in common with the original proposal.

Budget (Fr. bougette, Ital. bolgetta). In a general sense means a condensed statement of the income and expenditure of a nation, or of any particular public department. In this country, the Budget is annually brought forward by the Chancellor of the Exchequer, who in his speech gives a general view of the public revenue and expenditure, and intimates whether government intend to propose the imposition or repeal of any taxes, &c.

Buff Leather. A leather prepared by imbuing the prepared skin with an aluminous compound, and afterwards some oily matter, such as yolk of egg.

Buffalo. [BUBALUS.]

Buffers. Elastic cushions attached to railway carriages for the purpose of breaking the shock when one carriage is pushed against another. They are usually formed of horsehair covered with leather; but may consist of strong iron springs, or of vulcanised caoutchouc.

Buffy-coat. When the coagulation of blood is retarded so as to allow the red particles to sink, and the lighter white corpuscles to rise towards the surface, the supernatant opaline plasma coagulates without the red particles, but includes the white ones, and forms a light-coloured clot of fibrine and white corpuscles resting upon the main body of the coagulum which has included the red corpuscles, and constitutes what is called the 'buffy-coat.' It is indicative of inflammatory disease, during which the coagulation of the blood is retarded beyond the ordinary time.

Bug. [CIMEX.]

Bugle Horn (from bucula, *a heifer*). A musical wind brass instrument, latterly improved by keys, so as to be capable of all the inflections of the scale.

Buhl. [BOULE.]

Building Materials. These may be divided into calcareous, silicious, argillaceous and porphyritic. Of the first are limestones and marbles; of the second, sandstones; of the third, brick-clay and slates; and of the last, granites.

Limestones afford an excellent building material where they can be obtained on or near the spot where they are needed. Some are good enough and of sufficient repute to be worth carrying to a distance.

The best limestone for building purposes in England is Portland: a white and durable stone, obtained from numerous quarries in the Isle of Portland. These beds are among the upper members of the oolitic series. Cheaper and inferior, but valuable stones are obtained from quarries near Bath. These are called

Bath stone: they are of a warmer tint, softer, more absorbent, and lighter than Portland; but the best kinds are inferior to the best kinds of Portland. The Bath stone is from the upper part of the lower oolite. Very large quantities of excellent material are obtained from the lower oolites of Northamptonshire. The magnesian limestones on the borders of the coal measures in Derbyshire, Nottinghamshire, and the south of Yorkshire are locally valuable, and widely used. Varieties of chalk are sometimes employed for internal work, especially in cathedrals and churches.

Some of the foreign limestones and oolites are also used in England. Of these the Caen stone is the most remarkable. It is not unlike Bath, but the best kinds are harder and more durable.

Many limestones are durable when weathered to some extent before being exposed to the atmosphere of large towns; but few can stand that test without preparation. The magnesian limestone that has been so much animadverted on in reference to the Houses of Parliament, does not decompose in its own atmosphere, though unable to withstand that of London. A study of country churches and tombstones is therefore insufficient to justify an opinion as to the durability of limestone.

Sandstones are valuable building stones; some of the coal grits being of good colour, moderately hard, compact, and durable. Others decompose readily, especially if placed carelessly in a building. Craigleith stone from near Edinburgh is one of the most durable of these stones; and that of Darley Dale is also good. The value of sandstone for building purposes depends much on the cementing medium: where that is marly or calcareous there is little hold, but where it is silicious it is generally durable. Laminated sandstones, with green or red wavy lines, are rarely valuable. Grey stones with a moderate amount of mica are often very tough, and valuable for flags and paving as well as for building.

The granitic and porphyritic rocks are only economical where there is no other material at hand. They are difficult and costly to dress, even to the roughest shape, but they are very durable. The better kinds when polished are beyond all comparison the best materials for monumental purposes; but even granites need careful selection; some kinds, although tough and expensive to work, are liable to disintegration.

Marbles are generally durable in a dry atmosphere; but the fine white crystalline kinds are too costly for general use. The coloured marbles found in England are rarely employed for external work; but the compact semi-crystalline limestones of the carboniferous system are almost as beautiful and much cheaper.

Slates and slabs are of great value for constructive purposes, but chiefly for roofing and paving. They are now also largely used for internal work. [SLATES.]

Common clays are the minerals used in the manufacture of brick. Their value depends on various circumstances. [BRICK CLAY.]

Among constructive materials the various cements should be mentioned. They will be found described in another article. [CEMENT.] There are also some excellent kinds of artificial stone, which are elsewhere noticed. [STONE, ARTIFICIAL.]

Bul. The name of the eighth month of the ecclesiastical year of the Jews (1 Kings vi. 38).

Bulb (Lat. bulbus, Gr. βολβός). In Botany, an organism formed of a collection of fleshy scales, arranged like those of a bud, of which the bulb is a modification. It is usually found underground, as in the hyacinth; but sometimes in the axils of the leaves, as in some lilies. The old botanists used to distinguish two sorts of bulbs, the tunicated and the solid, but the former is the only one to which the name is now applied. The so-called solid bulb is the corm, as found in *Crocus*.

Bulbodium. A kind of underground stem resembling a rhizome.

Bulbogemma. A name for those bulbs which grow on the stems of plants, as in the tiger lily and other species of that genus.

Bulbotuber. That kind of stem which the old botanists called a solid bulb, and the moderns more generally a corm. It is a solid underground stem, generally round or roundish, clothed with the withered remains of leaves, and producing buds on its surface, as in *Crocus*.

Bulbus Arteriosus. In Embryology, the third cavity developed upon the primitive arterial trunk; the first being the auricle, the second the ventricle. The trunks of the aorta and pulmonary artery are developed out of the bulbus arteriosus in the warm-blooded vertebrata. In Comparative Anatomy the muscular basis of the branchial artery in fishes is so called, which may be regarded as a retention of the embryonic structure by arrested developement.

Bulgeways. Are timber supports placed beneath the sides of a ship while building, and which furnish a steadying power during launching. They slip along the ways of the dock, and separate by the action of floating as soon as the vessel's hull has plunged into the water.

Bulimia (Gr. βουλιμία, literally *ox-hunger*). A morbid appetite for food.

Bulkhead. The sea term for any partition, as of wood, canvas, or other material. Modern steamers for ocean traffic are rendered additionally safe by being divided into several compartments by means of water-tight bulkheads.

Bull, Golden. In German History, a term applied particularly to a statute or enactment of the emperor Charles IV., published A.D. 1356, in two diets held in succession at Nuremberg and Metz, for the purpose of fixing the laws in the election of the emperor, and of regulating the number and privileges of the electors (Churfürsten). The original copy of

this instrument is preserved at Frankfort-on-the-Maine, and has a seal of gold appendant: whence the appellation Golden Bull is derived. (Milman, *History of Latin Christianity*, book xii. ch. xi.)

Bull, Papal (Lat. bulla). An instrument, ordinance, or decree of the pope, equivalent to the proclamations, edicts, letters patent, or ukases of secular princes. Bulls are written on parchment, to which a leaden seal is affixed, and are granted for the consecration of bishops, the promotion to benefices, and the celebration of jubilees, &c. The publication of papal bulls is termed fulmination; and it is done by one of three commissioners, to whom they are usually addressed. The seal or 'bull' is thus described by Matthew Paris, anno Dom. 1257: 'In bulla domini Papæ stat imago Pauli a dextris crucis in medio bullæ figuratæ, et Petri a sinistris.' Bulls are generally designated by the first words of their text: thus, the bull *Unigenitus*, or *In cœna Domini*, &c. [Bulla.]

Bull's Eye. In Architecture, the technical name given to a description of glass lens used for the purpose of concentrating the light of a given centre upon an object; it is also applied to a circular window of plain glass.

Bull's Nose. In Architecture, the external angle of a polygon, or of two lines which meet at an obtuse angle.

Bulla (Lat.). A stud or boss, but more particularly an ornament in the shape of a heart, worn round the neck by noble Roman children till they were seventeen years old, when they assumed the manly dress of the toga, and suspended the bulla as a consecrated offering to the *lares* or household gods.

Bulla. A genus of Acerous Gastropodous Molluscs, the shell of which is more or less globose, or inflated like a bubble; having a spire not visible or projecting, but concealed by the large external whorl, which is elevated above the rest. The columella makes a convex prominence, which gives a crescentic form to the aperture of the shell. The animal breathes by gills, but has no respiratory tube or siphon, and consequently the margin of the aperture of the shell is entire, or without a fissure or canal. All the species of bulla are remarkable for a shelly apparatus of three pieces which converts the stomach into a gizzard or triturating cavity. These gastric calcareous pieces have been described as a bivalve shell of a new genus.

Bullet. The projectiles fired from small arms only are called bullets. The bullet for the Enfield rifle now in use in the service is ·55 inch in diameter, 1·0625 inch in length, and weighs 530 grains. It is elongated, and has a small boxwood plug fitting into a hollow at its base, which, receiving the first shock of the explosion, is driven forward into the bullet, causing the lead to bulge out, and thus fit the bore tightly, and fill the grooves.

Bulletin (Fr. from Mod. Lat. bulleta). In Diplomatics, a term equivalent to schedule, and variously applied to different public acts. In modern times, this name has been [illegible] especially in France, to reports of [illegible] facts issued by authority: as bulletins [illegible] bulletins of military events, &c.

Bullion (Fr. bouillon). Uncoined [illegible] silver. The word originally meant [illegible] office where the precious metals were [illegible] to the proper alloy and converted into [illegible] money. For the history of the word [illegible] Wedgwood, *Dictionary of English E*[illegible]

Bulwark (Dutch, bolwerck, [illegible] *made of* boles *or trunks of trees*: [illegible] wood). On Shipboard, is the parapet [illegible] round the deck for the purpose of [illegible] ing men and goods from slipping over[illegible] and at the same time for protecting [illegible] from the waves. In ships of war the [illegible] is of considerable solidity and height [illegible] the crew cover from an enemy's small [illegible] The hammocks are ordinarily stowed in [illegible] bulwark during the day.

Bumbelo. A glass flask of flattened [illegible] shape, in which camphor is sublimed.

Bumboat. A boat allowed to at[illegible] ship to supply the sailors with articles of [illegible] visions, clothing, &c.

Bumkin (perhaps a diminutive of [illegible] Ger. baum, *a tree*, also *a beam*). On [illegible] board, is a short boom fixed on each side [illegible] bow for the purpose of stretching the [illegible] farther to windward than the width of [illegible] deck at that part permits. It has a [illegible] block at the end, through which the tack [illegible] sail is worked.

Bunt. A parasitic fungus, called *T*[illegible] *caries*, having globose spores with a cellular coat, in which it differs from other *Ust*[illegible] the group of *Fungi* to which it belongs. [illegible] inflicts great damage on wheat. According [illegible] Mr. Berkeley, the best remedy is to w[illegible] seed corn thoroughly with a strong solution [illegible] Glauber's salts, and then dust it with q[illegible] lime.

Bunt Lines. In Navigation, used [illegible] gathering up the centre part of a square s[illegible]

Bunt of a Sail. Is that portion near[illegible] central perpendicular line. If a sail be d[illegible] into four equal portions, from side to side, [illegible] bunt would comprise the two central strips.

Bunter Sandstein. The German de[illegible] nation, imported into English Geology, of [illegible] lower portion of the Triassic series as dev[illegible] in Central Europe. It consists there of co[illegible] sandstones overlaid by fissile and incoh[illegible] beds. Large quantities of this deposit [illegible] the Vosges mountains, covering the *grès Vosges*, or lower new red. In England there [illegible] often little distinction between the Bunter sa[illegible] stein or lower and the Keuper or upper me[illegible] ber of the Trias, owing to the absence of [illegible] calcareous middle member or Muschelkalk. A conglomerate bed forms the usual u[illegible] member of the Bunter, and certain st[illegible] called *waterstones* the base of the Keuper.

The Bunter sandstein is known in Fr[illegible] Geology as the *grès bigarré*. It is there gene-rally a fine-grained solid sandstone, useful as a

building stone. Its colour is sometimes white, but more frequently of a blue, red, or greenish tint. Some of the intermediate beds make good millstones. In some districts the Bunter sandstein contains many fossil plants. In other respects fossils are very rare.

Buoy (Dutch boei, Fr. bouée, Span. boya). A floating body formed of wood, and very often of hollow iron, moored over a certain spot, to indicate the situation of a shoal or sand bank, and to mark out the course a ship is to steer. When used for this purpose, buoys are usually close vessels in the form of a cone, of large dimensions, in order that they may be seen from a distance; and generally painted of some particular colour, so as to be readily distinguished from one another. Public buoys in this country were placed by warrant of Queen Elizabeth under the management of the Corporation of the Trinity House, and the amount of revenue annually collected for their use is between 11,000*l*. and 12,000*l*. Small iron buoys are used for the purpose of indicating the situation of ships' anchors (to which they are fastened by a rope), in order that the ship may be prevented from running foul of the anchor, and that the anchor and cable may be recovered when the latter has been broken or cut.

Buphaga (Gr. *βουφάγος*). A genus of Conirostral Passerine birds, of which the African beef-eater (*Buphaga africana*) is the sole example. It derives its name from its habit of sedulously extracting from the backs of cattle the larvæ of œstri and other Dipterous insects which are deposited therein.

Buprestis (Gr. *βούπρηστις*, from *πρήθω*, *to swell*). The name of a Linnæan genus of Coleopterous Serricorn insects, now the type of a family (*Buprestidæ*), including the most splendid and brilliant beetles. Of this family upwards of a thousand species are known; by the French they are termed 'Nichards.'

Buratite (named after M. Burat). A mineral found in Calamine at Loktefskoi in the Altai, at Chessy near Lyons, &c. It is a hydrated carbonate of zinc, copper, and lime, and it occurs in radiating acicular crystals, of a verdigris-green colour.

Burden (Fr. bourdon, *a staff*). In Music, the drone or bass in some musical instruments, and the pipe or string that plays it. The bass pipe in the bagpipe is so called. Hence, that part of a song that is repeated at the end of every stanza is called the burden of it.

Bureau (Fr.). Originally a writing table; afterwards applied to the office of any public or private functionary where business is transacted.

Bureaucratic or Bureaucracy. Is the system by which the business of administration is carried on in departments, each under the control of a chief, in contradistinction to those systems in which the officers of government have a coordinate authority.

Burette (Fr.). An instrument occasionally used in the chemical laboratory, and in the assay office, for the purpose of dividing a given portion of any liquid into 100 or 1,000 equal parts.

Burg-grave (Ger. burg-graf). In the German Empire, a castellan or lord of a castle, having the right of private justice, imposing taxes, &c.

Burgage Tenure. In Law, an ancient tenure proper to boroughs; under which tenements are held of the king, or other person, at a rent certain. In several boroughs such holdings conferred the electoral franchise previous to the Reform Act.

Burgee. In Nautical phraseology, is a flag which ends in two points.

Burgh Mote (borough meeting). An Anglo-Saxon term for the borough court. *Berg mote* is the title of a court of miners, held in Derbyshire.

Burghbote. In the old English laws, was an impost levied for the raising or repairing of the defences of a borough or city.

Burghers and **Antiburghers.** In Ecclesiastical History. Owing to an undue exercise of patronage, which took place under the authority of the church of Scotland, or to the induction of a clergyman into a parish (Kinross) against the declared sentiments of the congregation, a schism took place in the church, which occasioned a secession from that establishment, and ultimately led to what is called the Burgher and Antiburgher denominations. Certain deposed clergymen constituted themselves into an ecclesiastical court, called the *Associate Synod.* To the deposed ministers and their adherents the name of *Seceders* was applied; and hence the origin of the *Secession Church* in Scotland. In 1745, they formed themselves into a synod, which consisted of three different presbyteries. But shortly afterwards they divided on the question of the lawfulness of an oath commonly administered to burgesses in towns. This dispute, which commenced at the meeting of the Synod in 1745, continued to be maintained with increasing acrimony for two years, or till 1747. The party that were in favour of the oath were called *Burghers*; the party that opposed it were termed *Antiburghers.* The latter finally withdrew in a body; Mr. Mair, one of their number, having previously protested that 'hereby the Burghers had forfeited all their synodical powers, and that the whole power of the Synod devolved on himself and his party and such as clave to them.' Next day, the Antiburghers held a synod composed exclusively of their own adherents, twenty-two in number, including ministers and elders, and constituted themselves into a distinct and separate sect of Christians. (Brown's *Hist. Acc. of the Rise and Progress of the Secession.*)

The chief practical difference that obtained between the church of Scotland and the Seceding bodies consisted in the one cleaving to patronage, and in the other having abolished that system, and introduced popular election in its stead. Besides, though the church has always been governed by kirk sessions, presbyteries, synods,

and a general assembly, the Burghers and Antiburghers, owing to the comparative paucity of their numbers, never adopted a general assembly. With them the synod was the supreme court, whose authority was final in all religious and ecclesiastical matters. The Seceders also were stricter Calvinists, and adopted more rigid discipline as to admission to church membership and *sealing ordinances* (baptism and the Lord's Supper) than the church party had perhaps ever done. (*Ib.*)

In 1820 the two bodies became reunited, and assumed the denomination of the *United Associate Synod of the Secession Church*. At that time, the Burgher persuasion comprehended 10 presbyteries, embracing 120 congregations; and the Antiburghers 11 presbyteries, consisting of 141 congregations. Since their union, their conjoint influence and extension have been considerably on the increase; in 1859 the 'United Presbyterian Church' counted 528 congregations: and it was said that a fifth part of the population of Scotland was connected with it. (M'Culloch's *Stat. Acc. of the British Empire*, ii. 425-7.)

Burglary (Low Lat. burgi latrocinium, *robbery committed in a burg or fenced place*). In Law, is the breaking and entering the dwelling-house of another in the night time, with intent to commit a felony. This offence is punishable by transportation or imprisonment.

Burgomaster (Ger. bürgermeister, *chief of the citizens*). The usual title of the chief municipal officer in German and Dutch towns. In the German free cities, the president of the executive council is styled bürgermeister; but in many towns of importance, the title stadtdirector (town-governor) has been recently substituted in its stead.

Burlesque (Fr.; Ital. burlesco, from burlare, *to jest*). The Italian poesia burlesca signifies merely comic or sportive poetry; but the term, in French and English, is more commonly restricted to compositions of which the humour consists in a ludicrous mixture of things high and low, as high thoughts clothed in low expressions, or, vice versâ, ordinary or base topics invested with the artificial dignity of poetic diction. The humour of parody or travestie [PARODY] arises from the burlesque. *Burletta*, a slight comic musical drama, is derived from the same origin.

Burmanniaceæ. A small natural order of Endogens, related to Orchids.

Burnet. A British plant, whose leaves have been used as food for sheep. It grows on poor calcareous soils, where few other plants will succeed, and in this its principal value consists; it is moreover perennial, and remains green all the winter. It is the *Poterium Sanguisorba* of botanists.

Burning Glasses and **Burning Mirrors.** The name given to glasses or mirrors so formed as to collect the sun's rays which fall on them into a point or small surface, and thereby produce an intense heat, and set fire to combustible substances. The point at which the rays meet, and where the greatest heat is produced, is called the *focus* or *burning point*. The rays of light or heat may be concentrated either by refraction or reflection: in the former case they must pass through a transparent refracting substance, as glass formed into a proper shape: in the latter they fall on a concave polished surface of silvered glass or bright metal. Reflectors made of glass are usually termed mirrors, those of metal *speculæ*.

The method of exciting heat or producing fire by the concentration of the sun's rays was known from remote antiquity; but the most famous recorded achievement of this kind is that of Archimedes, who is reported to have burned by means of mirrors the Roman fleet in the harbour of Syracuse. Considerable doubts have prevailed respecting the truth of this statement, chiefly grounded on the circumstance that although the setting fire to the fleet is positively affirmed by Dion, Diodorus Siculus, Pappus, and others, no mention is made of it by Livy, Polybius, or Plutarch, who are otherwise minute in detailing the mechanical contrivances of Archimedes, and who were not likely to pass over so notable an occurrence without notice. Descartes went so far, indeed, as to treat the whole relation as fabulous, affirming the thing to be impracticable. Its practicability was, however, experimentally demonstrated by the celebrated Buffon, who, by a combination of plane reflecting mirrors, produced results which must be regarded as of still greater difficulty. With 168 mirrors, each about six inches square, he set fire to planks of beech 150 feet distant, and this with the faint rays of the sun at Paris in the month of March. It is not necessary to suppose that Archimedes could not place his apparatus within that distance of the fleet of Marcellus: besides, by multiplying the number of mirrors, the concentration of the rays may be increased almost to any extent. All this, however, does not prove the actual fact related of Archimedes. Buffon, with all the resources afforded by the advanced state of the arts in the middle of the eighteenth century, and after a number of experiments, succeeded, with considerable difficulty, in constructing an apparatus by means of which he could inflame combustible substances at a considerable distance. The low state of the arts in the time of Archimedes must have rendered the undertaking considerably more difficult. The silence of those historians who have detailed his other mechanical contrivances can hardly be accounted for, supposing the story to be true.

In preparing a burning glass, the first thing to be considered is the figure necessary to collect all the rays into the smallest possible space. Descartes, in his *Optics*, showed that a disc of glass, convex on the one side and concave on the other, the convex side being a portion of an elliptic surface, and the concave a portion of a sphere, would cause parallel rays falling on its convex side to converge in a single point. But as the practical difficulties of forming a glass accurately into this shape are insuper-

able, both sides are ground into portions of a sphere. In a lens the focal length depends on the curvature, or the radius of the sphere, and on the refractive power of the substance of which the lens is formed.

The proper form for a burning mirror is the parabola; but as a parabolic curve is exceedingly difficult to obtain either upon metal or glass, opticians frequently rest content with a spherical curvature of long focus. Recently, burning mirrors have been constructed of glass, upon the curved surface of which pure silver is precipitated by chemical means. By this plan the curved surface is produced upon glass, and thus becomes permanent, whilst the reflection is effected by the polished surface of the silver, which can be easily renewed from time to time. The focus of a burning mirror is one-half of the radius of curvature.

Among those who have experimented, in modern times, upon the effects of burning glasses or mirrors, are reckoned Baron Napier, the illustrious inventor of the logarithms, Kircher, Dr. James Gregory, Sir Isaac Newton, and many others. The most powerful solid lens ever constructed was the work of Mr. Parker, an ingenious London artist. It was made of flint glass, was 3 feet in diameter, 3¼ inches thick at the centre, its focal distance 6 feet 8 inches, the diameter of the burning focus 1 inch, and its weight 212 pounds. The rays refracted by this lens were received on a second, the diameter of which in the frame was 13 inches, and its focal length 29 inches. The diameter of the focus of the combined lenses was half an inch; consequently, by the addition of the second lens, the burning power was increased four times. With this lens some of the most refractory substances were fused in a very short space of time: for example, 10 grs. of common slate in 2 seconds; 10 grs. of cast iron in 3 seconds; 10 grs. of lava in 7 seconds; 10 grs. of jasper in 25 seconds, &c. This glass was afterwards carried to China by one of the officers who accompanied Lord Macartney, and left at Pekin. (For detailed information on this subject, the reader may consult the article 'Burning Glasses' in the *Encyclopædia Britannica*, 8th edition.)

Burnishing. In Gilding, this operation is performed with pieces of agate set in sticks, which, being rubbed over the surface of the gold-leaf, greatly increase its brilliancy. The parts which are intended to be in dead or *matt* gold are left unburnished.

Burr Stone or **Buhr Stone.** A coarse cavernous stone, consisting almost entirely of silica, but full of cavities, and wearing in such a manner as always to expose a rough cutting surface. For this reason it makes an excellent mill stone. The best European burr stones are from France, the island of Sardinia, and Germany. The former are generally tertiary or oolitic; the latter of volcanic origin.

Bursæ Mucosæ. In Anatomy, synovial serous sacs, either subcutaneous or situated beneath tendons that glide over bones.

Bursars (Low Lat. bursarius, Fr. boursier, literally, *a purser*). In the English universities, this name is applied to the treasurers of colleges and halls.

In the Scottish and foreign universities it is applied to persons who are aided in their education by the grant of a small sum from a *burse* or fund set apart for that purpose. In the university of Edinburgh there are but few bursaries. George Heriot's Hospital (the most wealthy institution in Edinburgh) grants ten bursaries of 20*l.* per annum each, for four years, to persons not connected with the hospital, who, after a comparative trial before a committee of the governors of the institution, are found duly qualified. There are, besides, a few bursaries of 7*l.* and 10*l.* each given by the city of Edinburgh to students in the first year of their academical course; two of 10*l.* each to students named Stewart in the second year, and one of 100*l.* to a student selected from those called M'Pherson in the fourth year. To those may be added two ancient bursaries instituted for the benefit of Poles resident in Scotland, which, after lying dormant upwards of a century, were discovered and brought to light in 1837. At St. Andrews, there are several bursaries in the gift of the university; and at Aberdeen, besides the interest of 7,000*l.* devoted to the maintenance of certain students at that university, there are a few valuable exhibitions to Cambridge. At Glasgow the most important endowments of this kind are a few exhibitions to Oxford; and those left by Dr. Williamson for Englishmen not connected with the established church.

In Germany, where the system is largely carried out, the bursaries are called Frei-tische, or free-tables.

Burschenschaft (Ger.). A league or secret association of burschen, or students, formed in 1815, for the purpose, as was asserted, of the political regeneration of Germany, and suppressed, at least in name, by the exertions of the governments.

Burseraceæ. A name formerly applied to a natural order of hypogynous Exogens, now more generally called *Amyridaceæ*. It consists of trees and shrubs inhabiting the tropical parts of the world. They all are resinous and fragrant, having alternate unequally pinnate dotless leaves, and racemes or panicles of small green flowers. Their fruit is usually a drupe. Indian Frankincense, Myrrh, Olibanum, Colophane, the Balsams of Acouchi, Gilead, and Mecca, Gum Elemi, and other similar substances, are obtained from plants of this order; besides oil, pitch, and turpentine, resembling the vegetable secretions bearing those names in Europe.

Burster. The charge made up into a cartridge for bursting a shell.

Busby. The headdress worn by hussars, artillery and engineers in our army. It consists of a fur hat with a bag hanging from the top over the right side. This bag, which is made of the same colour as the facings of the regiment, appears to be a relic of a Hungarian

head-dress, from which a long padded bag hung over and was attached to the right shoulder as a defence against sword-cuts.

Bushel. An English measure of capacity, containing 8 gallons. By Act of Parliament, 5 Geo. IV. c. 74, the Imperial gallon is declared the standard measure of capacity, and is directed to be made such as to contain 10 lbs. avoirdupois of distilled water, weighed in air at the temperature of 62° of Fahrenheit's thermometer, the barometer standing at 30 inches; or to contain 277 cubic inches and 274 thousandth parts of a cubic inch. Consequently the Imperial bushel contains 80 lbs. of distilled water, or 2,218·192 cubic inches.

The *heaped* bushel of 2,815 cubic inches, declared by the same Act as a measure for coals, lime, potatoes, fruit and fish, was abolished in 1835 by Acts of Parliament 4 and 5 Wm. IV. c. 49. The Winchester bushel, in use from the time of Henry VII. to 1826, contained 2,150·42 cubic inches. The original standard Winchester bushel and yard measure are still preserved in the museum at Winchester. [WEIGHTS and MEASURES.]

Bushmen (Dutch, Bosjesmannen, *men of the wood*). A name given by the Dutch colonists to some roaming tribes akin to the Hottentots, in the vicinity of the Cape of Good Hope. The description given by Governor Janssens of this people is very interesting. So deep are they sunk in barbarism as to be unacquainted even with the construction of huts or tents: 'the burning sky being their canopy, and the scorching sand their bed.' They are of a dark copper complexion, small in stature, and of a singularly malicious, wild, and intractable disposition.

Busiris. In Egyptian Mythology, a fabulous personage, of whose origin, exploits, and character the most contradictory accounts are given, some maintaining that he was a king of Egypt, others that the name signified only the tomb of Osiris. [OSIRIS.]

Buskin (probably bootikin, or *little boot*). A species of covering for the leg, or rather for the ankle and foot: generally used by English writers as a translation of cothurnus, caliga, and various other Greek and Latin words denoting different kinds of boots, &c. Hence *buskin*, in the sense of *cothurnus*, stands for the tragic drama, in contradistinction to *soccus*, the boot or sock worn by comedians, and used for the comic drama.

Great Fletcher never treads in *buskins* here,
Nor greater Jonson dares in *socks* appear.—DRYDEN.

Buss. A two-masted vessel used by the Dutch and English in the herring fishery. It is nearly obsolete now; but when employed is from fifty to seventy tons in burden.

Bustamite (named after the discoverer M. Bustamente). A greyish red variety of Rhodonite (or native silicate of manganese), occurring in irregularly disposed prismatic crystals, having at times a fibrous structure, at Real de Minas de Tetala, in Mexico.

Bustard. [OTIS.]

Butea (named in compliment to John, earl of Bute, a patron of botany). A genus of Indian *Leguminosæ*, consisting of trees and shrubs, which yield kino. *B. frondosa* (the Dhak-tree) affords a gorgeous spectacle when in flower, the masses of blossom resembling sheets of flame. It exudes from the bark of its trunk an astringent juice, which when hardened forms one of the substances known as Kino.

Butic Acid. A solid matter contained in cow's butter in combination with glycerine.

Butomaceæ (Butomus, one of the genera). A natural order of endogenous aquatic plants, of the Alismal alliance. *Butomus umbellatus*, the Flowering Rush, is one of the most elegant of our native water plants.

Butt. A mound of earth used to receive the projectile at proof of and practice with firearms.

Butt Hinge. A hinge of cast or wrought iron, in which the flaps close like a book: it is usually let in flush with the bead of a joint left for the purpose of concealing it. Projecting butts are those which are used when doors have to fold back, flat, against the side of the walls intended to receive them.

Butt Joint. The joint which is formed in Carpentry when two pieces of timber meet one another at right angles, and the fibres are parallel with the main axis of the abutting pieces.

Butter (Gr. *βούτυρον*, from *βοῦς*, and *τυρός*, *cheese* or *coagulum*). The oily part of milk: 100 parts of cream contain about 4·5 of butter and 3·5 curd; they are separated by the process of churning, during which the butter aggregates. Butter soon becomes sour and rancid, unless purified by melting and straining it so as to separate adhering curd; it is generally preserved by the addition of salt. Its *elain* or oily part has been called *butyrine*. When converted into soap, it is said, in addition to the usual products, to afford three odorous volatile compounds, which have been termed by Chevreul the *butyric*, *capric*, and *caproic acids*.

Butters, Mineral. A name given by the old chemists to some of the *chlorides* on account of their soft butyraceous texture when recently prepared; such as *butter of antimony*, *of tin*, and *of bismuth*.

Butters, Vegetable. The concrete fixed oils, such as those of the cocoa and chocolate nuts, of the nutmeg, &c., which are solid at common temperatures.

Butter-tree. A name given to certain remarkable trees of the genus *Bassia*, one of which, *Bassia Parkii*, the Shea-tree or Butter-tree of Africa, found by Park in the interior of Africa, yields from its kernels, by pressure, a white firm rich butter, which, even in that climate, will keep well for a year without salt. Another species is the Phulwara or Butter-tree of India (*Bassia butyracea*), whose seeds produce a firm agreeable buttery substance, of about the consistence and colour of hog's lard, used medicinally in rheumatic affections. The

Illupie-tree of Coromandel (*Bassia longifolia*), and the Madhuca-tree of Bengal (*Bassia latifolia*) are other species having similar properties.

Butterfly. The common English name of an extensive group of insects, as they appear in their last and fully developed state, when they constitute the most beautiful and elegant examples of their class. These insects belong to the order LEPIDOPTERA, and to the section DIURNA of Latreille, or the genus PAPILIO of Linnæus. [See those words.]

The changes of animal form produced by the progressive expansion of the enclosed organs of the body, and the successive shedding of the outer case or skin, are in no instances so striking or so extraordinary as in the present group of insects. These changes or metamorphoses, as they are commonly but incorrectly termed, have been a favourite theme to the divine and the poet, and a most attractive subject of research to the naturalist. The transition of the humble grub to the gorgeous imago is the subject of the following beautiful passage in the classical work (the *Introduction to Entomology*) of Kirby and Spence: 'Were a naturalist to announce to the world the discovery of an animal which for the first two years of its life existed in the form of a serpent; which then, penetrating into the earth, and weaving a shroud of pure silk of the finest texture, contracted itself within this covering into a body without external mouth or limbs, and resembling more than anything else an Egyptian mummy; and which, lastly, after remaining in this state, without food and without motion, for three years longer, should at the end of that period burst its silken cerements, struggle through its earthly covering, and start into day a winged bird—what, think you, would be the sensation excited by this piece of intelligence?' The subterraneous locality of the insect in its passive state, and the silken shroud, are, indeed, less applicable to the butterflies than to other insects; but the circumstances attending the transformations of these beautiful objects are not less remarkable than those of the beetles and moths.

The eggs of the butterfly are deposited on such plants as afford the nutriment most appropriate to the caterpillars that are to be excluded from them; thus the common white butterfly (*Pieris brassicæ*, Latr.) and other species oviposit upon cabbages, and hence have been termed *Brassicariæ*: the gaudy peacock-butterfly lays her eggs upon the nettle. The eggs are coated with a glutinous secretion as they are excluded from the parent, and thus provided with the means of adhesion to the leaves or stems of the plants selected.

The larvæ are long and cylindrical, and consist of thirteen segments, including the head; they have eight feet, and nine spiracles on each side. Those feet which are attached in pairs to the first three segments of the trunk enclose the parts which are developed into the permanent legs of the future butterfly; the remaining five pairs of feet are membranous, short and thick, and are finally lost with the moultings of the skin, whence they are called 'pro-legs' by Kirby. The sides of the head are studded with twelve simple globular eyes, extremely minute, and very unlike the single large compound eye of the perfect insect. The mouth is provided with an apparatus characteristic of the mandibulate class of insects, having a pair of large and strong horny jaws working in a horizontal plane, and representing the 'mandibulæ;' beneath these a pair of smaller and softer jaws or 'maxillæ,' and a fleshy lower lip or 'labrum' united to the latter, and which is perforated by the outlets of the ducts of the complicated apparatus for secreting the silk. Such a condition of the 'instrumenta cibaria' or mechanism of the mouth is in perfect harmony with the habits of the caterpillar, and with the part assigned to this larva or masked Lepidopterous insect in the great theatre of nature. It is there destined to crop and devour the solid succulent parts of the otherwise too luxuriant vegetation, and must have jaws and teeth to perform its task. In its subsequent and final character the butterfly luxuriates on the exquisitely elaborated juices of the flower, and has the power to raise itself above the dull earth, and to transport itself through the air.

Button. The round mass of metal collected at the bottom of a crucible after fusion, or which remains in the cupel in the process of assaying, is called by this name.

Buttress. In Architecture, a mass of masonry, or brickwork, built to resist the horizontal thrust of another mass; though when they are on the opposite side to the thrust and below the line of its effort, they are frequently called *counterforts*. Buttresses are much used in Gothic architecture to counterbalance the outward thrust of the arches, or of the vaulting which covers the naves and aisles of cathedrals. When they are open, and carry down the thrust to a point of support at some distance from the spot where it is exercised, they are called flying buttresses.

Butts. Short ridges of different lengths, which necessarily occur in the angle of a field when the direction of the ridges is not parallel to one of the sides.

Butyl, Balyl or **Tetryl.** The radical or basis of a number of chemical compounds, of which butylic alcohol is perhaps the most important. The latter body is formed during the fermentation of beetroot molasses; a number of derivatives may be obtained from it resembling, more or less, those prepared from ordinary vinic alcohol.

Butyric Acid. One of the fatty acids contained in butter: it is also formed in certain cases in which sugar undergoes fermentation in contact with curd, and hence termed *butyric fermentation*. This acid is a volatile, colourless, and very mobile liquid, of a pungent sour odour, resembling that of a mixture of acetic acid and rancid butter; its taste is first pungent

and sour, then sweetish and etherial. The chemical formula of this acid is $C_8H_7O_3 + HO$; that is, the anhydrous butyric acid consists of 8 atoms of carbon, 7 of hydrogen, and 3 of oxygen; which in the ordinary acid are combined with an atom of water: in the *butyrates* this atom of water is replaced by an atom of base.

Butyrine. A solid fat composed of butyric acid and glycerine. It occurs in butter.

Butyrone. An interesting chemical substance occurring among the products of the distillation of butyrate of lime. It is homologous with acetone and propione.

Buxine. A bitter alkaloid contained in the tissues of the box-tree.

Buzzard. [FALCO.]

By-laws or **Bye-laws** (the first syllable from the Danish By, *town* or *hamlet*). Orders and constitutions of corporations, courts-leet and courts-baron, commoners, or inhabitants of vills, &c., of which the effect is to impose obligations not enforced by common or statute law. The validity of by-laws rests on the authority of the parties making them, established either by immemorial custom, or by their corporate character; for the power of making by-laws is inherent in a corporation. But the superior courts of law have the power of annulling a by-law, if it be unreasonable, or in restraint of trade, or imposing a charge without any apparent benefit to the party, &c. By the Municipal Corporations Amendment Act (5 & 6 Wm. IV. c. 76, s. 90) by-laws are to be made by the town council of the borough, and to be valid unless disallowed by the king in council within forty days.

Byard. A piece of leather crossing the breast, used by the men who drag the sledges in coal mines.

Byrrhus. A Linnæan genus of minute Clavicorn Coleopterous insects, now the type of a family, including those pests of museums which feed in the larva state on bird-skins, preserved insects, &c. The genera in this family are *Byrrhus* proper, *Simplocaria*, *Oomorphus*, *Syncalypta*, *Nosodendron*, *Aspidiphorus*, *Trinodes*, and *Anthrenus*. Of the latter genus there are six British species, of which the *Anthrenus muscorum* may be regarded as the type.

Byssifera, Byssifera (Lat. byssus, and fero, *I carry*). A family of Lamellibranchiate Acephalous Molluscs, comprehending those species which are attached to foreign bodies by means of a byssus.

Byssolite (Gr. βύσσος, *flax*, and λίθος, *stone*). A blue variety of Actinolite. It occurs in cavities of crystalline rocks in several parts of the Alps.

Byssus (Lat.; Gr. βύσσος). A fasciculus of shining semitransparent horny or silky filaments, secreted by a gland at the base of the foot in certain Lamellibranchiate Bivalves, and serving as an organ of adhesion to submarine rocks or other foreign bodies.

BYSSUS. A name formerly given to all those filamentous plants which inhabit cellars and other underground close places, and on which no fructification is found; it was also applied to vegetation of a similar kind when found growing in the air. It is now ascertained that a large number of these supposed plants are merely the young state of certain kinds of fungi, or other plants of a low organisation; and the genus is consequently exploded, the term Byssoid alone being retained to express a fringed structure in which the threads are of unequal lengths.

Bytownite. A mineral which is probably a mixture of different Felspars. It is found in large boulders near Ottawa (formerly called Bytown), in Canada West.

Byttneriaceæ (Byttneria, one of the genera). A natural order of Hypogynous Exogens, allied to the *Sterculiaceæ*, consisting of trees and shrubs, chiefly tropical or subtropical, with simple leaves, and monadelphous stamens. The order contains *Theobroma Cacao*, from the seeds of which chocolate and cocoa are prepared. The fibrous bark of many species is adapted for the manufacture of cordage.

Byzantine Art. In Ornament and Architecture, is that symbolic system which was developed by the early Greek artists out of the Christian symbolism. The great features are the circle and dome, the round arch, and all the various details of form which are derived from the lily, the cross, the vesica, the nimbus and other symbols. The great examples of this style are St. Sophia at Constantinople, and St. Mark at Venice. (Salzenberg's *Altchristliche Baudenkmale von Constantinopel*, &c. folio, Berlin 1854; Kreutz, *La Basilica di San Marco*, &c. folio, Venice 1843; and Ruskin's *Stones of Venice*, 1851–3.)

Byzantine Historians. A series of Greek historical authors, who lived under the Eastern Empire between the sixth and the fifteenth centuries. They may be divided into three classes: 1. Historians whose works form a continuous history of the Byzantine Empire from the fourth century of the Christian era down to the Turkish conquest of Constantinople. They are nearly thirty in number, with various shades of literary merit; but their works constitute almost the only authentic source of the history of that eventful period. 2. General chroniclers or historians, whose works treat chiefly of the chronography of the world from the oldest times. 3. Authors who confined their attention to the politics, statistics, antiquities, manners &c. of the Romans. These two latter classes combined amount also to about thirty, and their writings give an excellent illustration of the times of which they treat. The works of the Byzantine historians &c. were collected and published by order of Louis XIV. in 36 vols. folio, Paris 1645-1711. Another edition was published at Venice in 1729 and the following years. A more complete edition was projected by Niebuhr, the historian of Rome (*Corpus Scriptorum Historiæ Byzantinæ*, editio emendatior et copiosior, 8vo. Bonnæ 1828). This edition was superintended by him till his death; and it has since that time been carried on by Becker, Dindorf, and other eminent philologists.

C

C. The third letter of the English and most other European alphabets. It is borrowed immediately from the Latin alphabet, in which it first appears; but is derived originally from the κ or γ of the Greeks. In English it is pronounced like *s* before *e* and *i*, and like *k* before *a*, *o*, *u*, and may consequently be considered as superfluous in the alphabet. As an abbreviation, C is used in ancient MSS. for Caius, Cæsar, Consul, Civitas, &c.; and as a numeral for a hundred. It was the symbol of condemnation in the Roman tribunals (being abbreviated for *Condemno*); and was consequently termed *litera tristis*, in contradistinction to A (used for *Absolvo*), symbolical of acquittal, and thence called *litera salutaris*.

C. In Music, the name of one of the notes in the scale, corresponding to the *Ut* of the French, or the *Do* of the Italians. It is a character also used for the signification of Common Time. [Music.]

Ça ira (Fr. *It* [the Revolution] *shall go on*). The burden of a famous revolutionary song, which was composed in the year 1790 in denunciation of the French aristocracy. The object of the equally well known Marseillaise hymn ('Allons, enfants de la patrie') was to rouse the French to defend their country against foreign aggression.

Caaba. The name of the great temple at Mecca, given to it from the black stone which was worshipped there before the time of Mahomet (or Mohammed) and which is still an object of veneration to all Mahometans. According to the tradition of the Arabs, this stone was presented by the angel Gabriel to the patriarch Abraham on the occasion of the building of the temple; but the nature of the Caaba worship proves that there is nothing Abrahamic in the superstition. The temple had become ruinous, and was rebuilt while Mahomet lived at Mecca; and it is said that he himself guided the stone to its place in the north-east corner of the Caaba. This great object of Mahometan pilgrimage appears to be a large aërolite, and the veneration for it arose in the original Fetish worship of stones. (Muir's *Life of Mahomet*, vol. i. p. 210 &c. and ii. 34 &c.)

Cabal (Fr. cabale). In English History, was applied originally to the five cabinet ministers of Charles II.—Clifford, Ashley, Buckingham, Arlington, and Lauderdale—whose initials happened to form the word; and it has since been used for any junto of men who, too insignificant in point of numbers to form a party, endeavour to effect their purposes by underhand measures.

Cabala. A Hebrew word, signifying the body of generally received tradition by which the Rabbins interpreted the canonical Scriptures. According to their belief, the unwritten tradition, or Masora, had been handed down in regular succession from Moses, who received it on Mount Sinai. To this tradition frequent reference is made in the teaching of Christ, as in the Sermon on the Mount, &c.; and on it the Pharisees rested their claim to authority as interpreters of Scripture. As the Masora gives the literal explanation of the language of Scripture, so the Cabala reveals the hidden truths of which it is the symbol. Every sentence, word, and letter of the inspired volume contains, according to these interpreters, a figurative as well as a direct sense. The former is also not uncommonly manifold; and a word may be interpreted according to the arithmetical power of the letters which compose it, which species of cabala is called *gematria*; or according to the meaning of each individual letter, the entire word thus constituting a sentence, which is called *notaricon*; or finally according to certain transpositions of the letters, which is denoted by the term *themurah*. The system seems to have been an invention of the philosophising Jews of the latter centuries preceding our era, with the view of accommodating the speculations of the Gnostics to the religion of the Old Testament. (Milman's *History of Christianity*, vol. i. chap. i.; *History of the Jews*, book xix.)

The Christian cabalists in later times practised a kind of magic under this name, pretending to the power of divination by certain combinations of scriptural characters.

Cabiai. In Zoology, the name under which the Capybara or water-hog (*Hydrochœrus Capybara*, Erxl.) is described by Buffon. [Capybara.]

Cabin (Fr. cabane). A rough kind of enclosure for the purpose of protecting any one from the weather, such as shepherds erect in country districts. The origin of architecture is traced to these structures by the fanciful theorists who have written on the subject. Mazois gives in his work upon the ruins of Pompeii a representation of the early Italian cabins.

Cabin. On Shipboard, is a chamber of greater or less size, separated by light panelling from the rest of the deck. It serves as the apartment of some officer or passenger; or it may be a saloon for the use of many. In ships of war the partitions are readily removed when it is necessary to clear the decks for action.

Cabinet (Fr.). In Politics, the governing council of a country: so called from the cabinet or apartment in which the ruler transacts public business and assembles his privy council. In England a few of the ministers only are by official usage members of the cabinet. These are styled Cabinet ministers, and are more immediately responsible for the acts of the sovereign, as well as for public measures; but,

notwithstanding the high importance of their position, they have no recognised legal character. The distinction between the king's cabinet ministers and the rest of his privy council seems not to have been established in public usage in England before the reign of William III.

Cabiri (Gr. κάβειροι). Certain mystic deities, worshipped in Greece, Egypt, &c., and specially in Lemnos, Samothrace and Imbros. The vague and contradictory accounts given of them by various writers render it impossible to arrive at any certain conclusions as to their real character, and the nature of their worship, which was made a matter of the greatest mystery. By some they have been regarded as exclusively Pelasgic divinities; by others they have been identified with the Roman Penates and the Dioscuri. To account for their name, they were said to be children of Hephæstus (or Vulcan) and Cabeira the daughter of Proteus. They are mentioned by Herodotus (ii. 51, iii. 37); but his statements are not more definite than those of later writers. The subject is examined at length in Lobeck's *Aglaophamus*.

Cable (Fr. câble; Span. cabre, cable; Port. calabre, cabre). The rope or chain by which the anchor of a ship is held. Cables in Europe, until within a recent period, were usually made of hemp, but of late years iron chains have come much into use. A hempen cable of 12 inches girth, and length 120 fathoms, weighs 3,075 lbs. Since the weights of two cables of equal lengths will be as their sections, or squares of the girths, it is easy to deduce the following rule for the weight of any hempen cable: Multiply the square of the girth in inches by 21·3 (or 21 nearly enough); the product is the weight, in lbs. Since also as the breaking strain, or resistance against the force to part the cable, will be as the section, it will be as the weight, and will be found nearly by dividing the weight in lbs. by 100; the quotient is the breaking strain in tons. This rule is of course liable to great uncertainty from the quality or wear of the cable. Chain cables possess great advantages over hempen cables; they are not liable to be destroyed by chafing on rocky grounds, nor to become rotten and insecure from alternate exposure to the air and water; and by reason of their greater weight the strain is exerted on the cable rather than on the ship. In order that the ship may be enabled to let slip her cable in case of necessity, chain cables are furnished with bolts at distances from each other of a fathom or two, which can be readily withdrawn. A chain of which the section is 1 inch in diameter breaks with 16 tons; such a chain is equivalent to a 10-inch hemp cable nearly. And the dimensions of the chain cable corresponding to any hemp cable are therefore easily found by merely dividing the circumference of the hemp cable by 10. The strength of every part of the chain is proved before it leaves the manufactory, nor may any chain be used on shipboard until it has been tested and certified by an officer appointed by the Board of Ordnance. The penalty for supplying a cable not so tested is 50*l*. The first patent for a chain cable was taken out in 1808 by Mr. Slater, a surgeon in the Royal Navy.

Cable. In Architecture, the term cable is applied to a moulding that is ornamented in such a way as to resemble a cable; it is frequently applied to the lower part of a column, which is filled in with a decoration of this kind inserted in the flutes.

Cabled. In Architecture, the filling up the lower part of the flute of a column with a cylindrical piece like a cable.

Caboclo. The Brazilian name for a compact brick-red mineral, resembling red Jasper, which is found in the diamond-sand of the province of Bahia. It contains phosphoric acid, alumina, lime, baryta, protoxide of iron, and water.

Cabombaceæ (Cabomba, one of the genera). A small order of Exogens belonging to the Nymphal alliance. The plants are aquatics, with floating shield-like leaves and three to four petaled flowers, and are found both in North and South America, as well as in New Holland. The distinguishing peculiarities of the group are their distinct carpels, the abundant albumen in the seeds, and the absence of a torus. The order has sometimes been called *Hydropeltideæ*, and bears the popular name of Watershields. The submersed leaves are capillary.

Cachalot. In Ichthyology, a name for the spermaceti or sperm whale (*Physeter macrocephalus*, Linn.).

Cachet, Lettres de (Fr.). In France, under the ancient government, letters signed with the private seal (cachet) of the king. As warrants for the detention of private citizens, they appear to have been rarely employed before the seventeenth century. In the reign of Louis XIV. their use became frightfully common. But in other respects they had been not unfrequently made use of, even in earlier times, to interfere with the course of justice; as, by way of injunction to a party not to exercise certain authority or pursue certain legal steps, &c. Lettres de cachet were never so multiplied as under the administration of Cardinal Fleury: not less than 80,000 are said to have been issued, without any legal judgment, in the proceedings against the Jansenists. Fifty-nine are said to have been issued against the family Mirabeau in the reigns of Louis XV. and Louis XVI., of which twenty-two were against the famous count himself. They were abolished Jan. 15, 1790.

Cachexia (Gr. καχεξία, from κακός, bad, and ἕξις, *a habit*). A bad state or habit of body; whence the term *cachexiæ*, or cachectic disorders.

Cacholong. A milk-white variety of Opal, allied to Hydrophane. It is found in Ireland, in the trap rocks of Iceland, in Greenland and the Faroe Islands. It was originally discovered on the banks of the river *Cach* in Bucharia, where it occurs in large loose masses: hence the origin of the name; the word *Cholong*, in the

language of the Calmucks, being said to signify a *stone*.

Cachunde. A celebrated Chinese medicine, composed chiefly of aromatic stimulants.

Cacodæmon (Gr. κακοδαίμων, *an evil spirit*). [DÆMON.]

Cacodyle. [KAKODYLE.]

Cacophony (Gr. κακοφωνία, from κακός, *bad*, and φωνή, *a sound*). In Rhetoric, a harsh or disagreeable sound produced by the meeting of two or more letters or syllables, or by the too frequent repetition of the same letters or syllables: e.g.

And oft the ear the open vowels tire.—POPE.

Cacotheline. A feeble alkaloid derived from brucine by the action of nitric acid.

Cacoxene. [KAKOXENE.]

Cactaceæ (Cactus, the old name of one of the genera). A small natural order of Exogens, remarkable for their gay and large flowers, and for the grotesque forms of some of the species, which are nearly all succulent. They are found wild in hot dry countries, in arid situations, where they are enabled to exist because of the thickness of their skin, which allows very little moisture to be lost through it. The principal features are the numerous undistinguishable sepals and petals, the scattered stamens, the confluent styles, and the exalbuminous seeds. Many of the species are like succulent Euphorbias, from which they are, however, known by their not giving a milky sap when wounded. All the species are harmless. Some have eatable fruit, as *Opuntia vulgaris*, the Prickly Pear; and one of them, the Nopal, *Opuntia cochinillifera*, is the favourite haunt of the cochineal insect.

Cacus. In Latin Mythology, the son of Vulcan, a robber of Italy, whose dwelling was in the Aventine wood. His exploits form the subject of an episode in the eighth book of the *Æneid*. He was represented as a frightful monster of enormous strength, who, after a long life of crime, was at length slain by Hercules, from whom he had stolen some oxen. To express his gratitude for his victory, Hercules erected the *Ara Maxima*; and Evander, with his infant colony of Arcadians, paid divine honours to Hercules as their benefactor. For the origin, history, and meaning of the myth, see Bréal, *Hercule et Cacus* (Paris, A. Durand, 1863).

Cadastral Survey (Fr. cadastre, from cadrer, *to square with*). A term of late years generally adopted on the Continent, and now used in England, to denote a survey on a large scale. A cadastral as opposed to a topographical map may be defined to be one on which the objects represented agree, as to their relative positions and dimensions, with the objects on the face of the country; while a topographical map, usually drawn on a small scale, exaggerates the dimensions of houses and the breadth of roads and streams, for the sake of distinctness, and is, owing to its smaller size, necessarily less correct than a cadastral plan. The scale on which the national survey of the United Kingdom is in future to be drawn, is that which has been generally adopted throughout Europe, namely ·0004, or $\frac{1}{2500}$ of the linear measure of the ground. This scale corresponds so nearly to twenty-five inches to one mile, that it is usually spoken of as the twenty-five inch scale. (*Edinburgh Review*, vol. cxviii. p. 378.)

Caddice-worms or **Case-worms.** The larvæ or grubs of the Trichopterous insects are so called, on account of being enclosed in a sheath or case. This is always composed of extraneous substances glued together by a cement excreted from the skin of the grub; and different species of the caddice-worm protect themselves by means of different materials thus joined together. Some, which pass their larva state under water and creep along the bottom, combine bits of sticks or rushes with small pebbles or shells, to make their cases heavier than water; others, which float on the top and there gather their food, form a slight and slender tube of a narrow slip of grass, which is rolled round the body in a spiral direction, with the edges so nicely fitting as to seem but one piece. In every case the worm adheres by a pair of hooks at its hinder extremity to the bottom of the sheath, and only protrudes the head and two following segments, the skin of which is harder than that covering the rest of the body. Those which creep at the bottom drag themselves along by means of their mandibles. At the conclusion of their existence as grubs, they moor their case to some large stone or other fixed and submerged body, and close the outlet by a network of silken threads, which prevents the entry of any unfriendly intruder, but admits the water necessary for respiration. They then cast their outer skin, and for a while remain in the usual passive condition of a pupa; while the organising energy is vigorously effecting the wonderful changes which lead to the full perfection of the insect. But, as it would be obviously dangerous to the air-breathing imago to be excluded in its first feeble state under water, the pupa here exhibits a locomotive power which is without a parallel in other orders of the metamorphotic insects: being provided with a pair of small and sharp hooks at the head, it cuts the threads with which in a previous state it had confined itself, and creeping out of the water casts off its pupa skin, and emerges a May-fly or *Phryganea*.

Cadence (Ital. cadenza, *a falling*). In Music, the conclusion of a song, or of some parts thereof, in certain places of the piece, dividing it as it were into so many numbers or periods. The cadence takes place when the parts fall or terminate on a note or chord naturally expected by the ear, just as a period closes the sense in the paragraph of a discourse. A cadence is either perfect or imperfect. The former when it consists of two notes sung after each other, or by degrees conjoined in each of the two parts, the harmony of the fifth

preceding that of the key-note; and it is called perfect, because it satisfies the ear more than the latter. The latter imperfect; that is, when the key-note with its harmony precedes that of the fifth without its added seventh. A cadence is said to be broken or interrupted when the bass rises a major or minor second, instead of falling a fifth.

Cadenza (Ital.). This term, although etymologically the same as cadence, is used to denote a passage in a concerto, introduced at the pleasure of the player, to exhibit his skill of performance or composition, immediately before the end of a movement.

Cadet. This word, meaning in French a younger member of a family, implies in English a student at either the Royal Military Academy at Woolwich, or the Royal Military College at Sandhurst. The cadets at these establishments, though neither commissioned as officers nor enlisted as soldiers, receive pay, wear uniform, and are subject to military discipline. In order to gain a commission in the Royal Artillery or Engineers, it is necessary to pass through the former of these establishments, and through the latter in order to obtain a commission without purchase in the Line. These cadetships are open to any British subject, within certain limits of age, who can produce certificates of good moral character, who is not physically disqualified, and who succeeds in the competition.

A much higher standard of qualification is required for admission to Woolwich than to Sandhurst, good mathematical attainments being indispensable; and as the number of candidates always far exceeds that of vacancies, the competition is very severe. The shortest time in which a cadet can pass through Woolwich is two and a half years; and the course of instruction, in addition to drill, gymnastics and riding, comprises the following subjects: mathematics, practical geometry, French, German, Hindustani, plan-drawing and surveying, mechanics, chemistry, experimental sciences, natural philosophy, geology and mineralogy, fortification and artillery. On passing their final examination at the Academy, the cadets state whether they wish to enter the Artillery or Engineers, and the highest are commissioned in whichever they prefer. The course of instruction up to the hour of leaving is the same for both services.

For Sandhurst, the entrance examination is easier: the course of study is of less duration, and comprises much the same subjects. The cadets who gain the highest places at the final examination get commissions without purchase; the remainder are allowed to purchase commissions as vacancies occur.

The field-marshal commanding-in-chief is governor of the Royal Military Academy at Woolwich, and under him is a general officer as lieutenant-governor. The government of Sandhurst is vested in commissioners, of whom the commander-in-chief is president: and a general officer is governor of the college. While the son of a private gentleman pays 125*l*. per annum for education at either of these establishments, the sons of officers pay less according to a sliding scale, the sons of lieutenants paying only 40*l*. per annum.

The chief military schools in France are the polytechnic school at Paris for the Artillery and Engineer cadets, and the military school at St. Cyr near Versailles for the Line; officers, however, in the proportion of one-third of the whole are obtained from the ranks of the army.

In Prussia there are four cadet schools in the provinces, and one upper cadet school at Berlin. After joining the army, every officer goes through a course of instruction before finally obtaining a commission.

In Austria the officer's education begins at an early age. The chief military school is at Wiener Neustadt near Vienna.

The Italian system is like the French, and the military school is at Turin.

The West Point Academy, in the United States, has educated some of the best officers who have been employed in the present American war.

In Russia there is a famous academy for cadets, which was instituted by the Empress Anna at St. Petersburg in 1732.

Cadet, Naval. Holds a sort of preparatory appointment in the British Navy. Young gentlemen are eligible for the rank from twelve to fourteen years of age. The nominations rest with the Admiralty, except that every captain on commissioning a ship has one, and every admiral on hoisting his flag has two. Candidates pass a preliminary examination, and are then draughted into a training ship, for a few months, for instruction in rigging and other technical matters. After eighteen months' service, a cadet becomes eligible for the rank of midshipman. Naval cadets of the second class, after their term of service, become master's assistants instead of midshipmen.

Cadet's Fuming Liquor. [ALCARSIN.]

Cadi (Arab. *a judge*). Among the Turks the inferior judges are styled Cadi. The Spanish Alcayde or Alcalde is derived from the same root. Cadi Lesker signifies a higher order of judge.

Cadmium. A white metal, much like tin: it fuses and volatilises at a temperature a little below that at which tin melts. Specific gravity about 9. Its ores are associated with those of zinc. It was discovered in 1818 by Professor Stromeyer of Göttingen. Its equivalent number is 56. It forms a yellow salifiable oxide composed of 56 cadmium + 8 oxygen = 64 oxide of cadmium. Its scarcity prevents its employment in the arts, but the oxide has been used as a pigment.

Caduceus (Lat.). In Antiquity, a rod of laurel or olive with a representation of two snakes twisted round it. It was the symbol of peace, and formed the chief badge of heralds, whose persons were held sacred. In Mythology the Caduceus was the symbol of Mercury, thence called Caducifer, to whom it was said to

have been presented by Apollo in return for his invention of the lyre.

Caducibranchiates (Lat. caducus, *falling*; branchiæ, *gills*). Those Batrachians which undergo a metamorphosis, and lose their branchial apparatus before arriving at the period of maturity; as the frog, toad, salamander, and newt.

Caducous (Lat. caducus). In Botany, when a part is temporary and soon disappears or falls off.

Cæca (Lat. cæcus, *blind*). In Comparative Anatomy, the blind processes of the alimentary canal are generally so called. Those in fishes occur at the beginning of the intestines, where they are often numerous and long, representing the pancreas. In birds they are found near the termination of the intestines, and are generally two in number. In mammals the cæcum is commonly single, and situated at the beginning of the large intestines; it is of enormous size in the herbivorous species with simple stomachs. In the lower animals the intestinal glands which communicate with the intestines generally retain their primitive form of cæca.

Cæcum (Lat. cæcus). In Human Anatomy, the first portion of the large intestines, in which the *ileum* terminates by a valve. The cæcum is a kind of appendage to the intestinal canal, open at one end only, whence the name *blind gut*; it has a small process attached to it, called the *appendix cæci vermiformis*.

Cænozoic or **Kainozoic** (Gr. καινός, *new*, and ζωή, *living*). A name introduced in modern Geology to include the whole group of Tertiary rocks. It corresponds with PALÆOZOIC and MESOZOIC [which see]. The more usual designations of Secondary and Tertiary must, however, for the present retain their place in geological works, although Palæozoic has entirely superseded Primary. [TERTIARY.]

Cæsalpinia (after Andreas Cæsalpinus, physician to Pope Clement VIII.). A genus of *Leguminosæ*, consisting of tropical trees or shrubs, and belonging to that division of the order in which the petals are imbricated, and the uppermost interior, not exterior, as they are in the papilionaceous division. *C. coriaria*, sometimes called *Labidibia coriaria*, produces the pods known in commerce as Divi-divi or Libi-dibi, used for tanning purposes. Brazil-wood and Nicaragua-wood, so important to dyers, are produced by other species, as *C. crista* and *echinata*; and *C. Sappan* furnishes the red dye wood called Sappan-wood. These trees have compound leaves, and their flowers have five unequal stalked petals, and ten stamens.

Cæsar. This title, originally the name of a branch of the Julian family at Rome, was assumed as a mark of dignity by the emperors after Nero. It became subsequently the title of the presumptive heir to the empire, and the next title of dignity after Augustus; but was superseded in the Greek empire under Alexis Comnenus by that of Sebastocrator. In the West, it was conferred on Charles the Great, and was borne by those who succeeded him on the imperial throne of the Holy Roman Empire. Although this dignity came to an end with the resignation of Francis II. in 1806, the title Kaiser is still assumed by the emperor of Austria. (Bryce, *Holy Roman Empire.*)

Cæsarean Operation. The extraction of the child from the womb by an operation. Julius Cæsar is said to have been thus brought into the world.

Cæsium. An alkaline metal discovered by Bunsen and Kirchoff in 1860, by a spectral analysis of the residue of the mineral water of Durckheim and Baden. A ton of the water was estimated to yield not more than three grains of chloride of cæsium. The metal derives its name from the Latin *cæsius*, signifying greyish blue, this being the colour of the two lines produced in its spectrum. Traces of it have been found in other waters. It is a white metal; it decomposes water, evolving hydrogen, and forming an alkaline solution of protoxide of cæsium.

Cæstus. [ATHLETES.]

Cæsura (Lat. from cædo, *I cut*). In Prosody, a metrical break in the verse, occasioned by the separation of the first syllable of a foot, forming the last of a word, from the next syllable, forming the first of another. In the Latin hexameter the principal cæsura, without which the line is unmusical, occurs generally after the tenth, sometimes not until after the fourteenth time—each long syllable containing two times, each short syllable one [RHYTHM]—thus:

> Arma virumque cano | Trojæ qui primus ab oris.
> Speluncæ vivique lacus | at frigida Tempe.

The slight pause which follows the syllable at which the interruption takes place is termed the cæsural pause. In English verse a line is frequently musical without any cæsura at all; i.e. in which the pause takes place always at the end of a foot. But a cæsura in the middle of the third and in the middle of the fourth foot of an heroic verse are by no means uncommon, and particularly appropriate in blank verse, in which they represent the two common cæsuræ of the Latin hexameter.

> I sing the sofa | I who lately sang.
> Of man's first disobedience | and the fruit.

In the first of these lines the cæsura is in the third, in the latter in the fourth foot.

Caffeic Acid. *Caffotannic* or *chlorogenic acid.* An astringent substance existing in coffee. It much resembles gallotannic acid.

Caffein. A bitter crystallisable substance contained in coffee. A portion of it volatilises during the roasting of coffee. It has not been applied to any use. [THEIN.]

Cahier (Fr.). Derived by some from the Lat. *codex*, by others from *quaternio*. It signifies in its proper sense a number of sheets of paper loosely tied together. In French history, it denotes the reports and proceedings of certain assemblies: as those of the clergy, the States-General, the notables, &c. The

famous cahiers presented by the States-General to the king of France at their convocation on the 24th of June, 1789, contains the best account of the then state of France. They were systematised and condensed in a book in three volumes, called *L'Esprit des Cahiers*, to which the reader is referred.

Cahoun-nuts. The fruits of *Attalea funifera*, which yield an oil resembling that of the cocoa-nut.

Caincic Acid. A peculiar acid discovered by Pelletier and Caventou in the bark of the cainca root, a Brazilian shrub employed for the cure of intermittent fever.

Cainites. A strange sect of heretics, who appeared about 159 A.D. They probably originated in some of the various schools of Manicheism; and, if their doctrines are truly reported to us, they are said to have asserted that the power which created heaven and earth was the evil principle; that Cain, Esau, Korah, the people of Sodom, and others whom the Old Testament represents as victims of peculiar divine judgments, were in fact children of the good principle, and enemies of the evil. Some of them are said to have published a gospel of Judas on the same principle. The Quintilianists, so called from a lady named Quintilia, of whom Tertullian speaks, were an offset of this sect.

Cairn. A Celtic word, used to denote the piles of stones of a conical form frequently found on the tops of hills &c. in various districts; erected probably, as Sir R. C. Hoare observes, in general, for the mere purpose of memorials, although some have assigned to them a peculiar character, as receptacles for the bodies of criminals burnt in the wicker images of the Druids, &c. According to some antiquaries, *cairn* is distinct from *carnedd*, the Welsh name for heaps of stones on the tops of high mountains (Carnedd David, Carnedd Llewellyn, &c.), which are said to have been sacrificial. Some cairns are undoubtedly sepulchral. In common language, a cairn is distinguished from a barrow, the former being a heap of stones, the latter a mound of earth; but in all probability they had for the most part the same object, and the difference of materials was merely occasioned by local circumstances. [BARROW.]

Cairngorm or **Cairngorum Stone.** The name given to pellucid wine-yellow varieties of Smoky Quartz, after the mountain Cairngorm in Inverness-shire, where they are found. They are also common in Scotland, throughout the central group of the Grampian Hills.

Caisson (Fr.). In Architecture, a sunken panel, in a flat or vaulted ceiling, or in the soffit of a cornice; in ceilings they are of various geometrical forms, and often are enriched with rosettes or other ornaments. In Civil Engineering, a caisson means an enclosure or large vessel, in which the foundations of a bridge are built in the dry; and the vessel being brought over the position assigned to it (the ground being first properly dredged, or prepared to receive it), the sides are removed, and the whole structure then subsides into its place. Sometimes the sides are designed to remain; and the foundations in those cases are protected by loose stones thrown down around the caisson. Westminster and Blackfriars bridges and Ramsgate pier were founded in this manner, which was a favourite one with the engineers of the last century; but it has not been found sufficient to protect the superstructure from the scour of the tides or currents. The term caisson is also applied to a kind of gate for the purpose of closing the entrance to graving docks or other similar works.

Cajanus (Catjang, the Malay name of one of the species). A small genus of *Leguminosæ* § *Papilionaceæ*, one species of which, *C. indicus*, is cultivated in tropical countries for the sake of its pulse, which is much used as food, under the names of Dhal, Congo Pea and Pigeon Pea. They are shrubby plants with trifoliate leaves, and axillary racemes of flowers, which are either yellow, or yellow streaked outside with crimson. The seeds, whether green or dry and split, are considered equal to peas.

Cajeput Oil. A volatile oil obtained by distilling the leaves of the *Melaleuca minor*, a shrub abundant in Amboyna and Borneo, whence the oil is imported. This oil is of various shades of green, highly pungent and aromatic, and powerfully stimulant and diaphoretic. It has been much extolled as a remedy in the Asiatic cholera, but other essential oils are probably as effectual.

Caking Coal. A term applied to those kinds of bituminous coal which form a pasty cake, or swell and expand in the fire somewhat in the manner of borax when exposed to heat.

Calabar Bean or **Ordeal Bean.** This is the produce of the *Physostigma venenosum*, and is imported from Africa, where it is used medicinally and as an *ordeal* in cases of suspected crime: if it causes vomiting, it indicates innocence; if purging, crime. It operates as an emetic and purgative, and also as a narcotic poison: it induces fainting fits and partial paralysis. Several cases are on record of accidental poisoning by this bean. In 1864 several children were poisoned by it at Liverpool, and one of them died; they had picked up the beans in some rubbish thrown upon a piece of waste ground, and derived from part of the cargo of a ship from Calabar. (*Pharm. Journ.* vi. 134.) See also a paper on this subject by Dr. Christison, who was nearly poisoned by eating about a fourth part of one of these beans. (*Phil. Trans. Edinburgh*, 1855.)

Caladium (of unknown derivation). The name of certain Araceous plants, the rhizomes or rootstocks of which are eaten as food in the West Indies and other tropical countries, the process of cooking removing the noxious qualities which, in common with other Arads, they possess from the abundant starch which they contain. The spathe is hood-like, rolled round the spadix, which bears ovules at the base, stamens at top, and blunt glands or sterile stamens between.

Calamary (calamus, *a pen*; theca calamaria, *the pen-fish*). A Cephalopod; so called because it has a horny substance shaped like a quill in its back, and contains an ink-bag in its visceral sac: it is the *Loligo vulgaris* of Cuvier.

Calamine (Lat. calamus, *a reed*). One of the most abundant ores of zinc, used in the manufacture of brass; *Lapis Calaminaris*. The name has reference to the way in which the ore, during the process of smelting, adheres to the bottom of the furnace in the form of reeds.

It is a native carbonate of zinc, composed of 64·81 per cent. of oxide of zinc and 35·19 carbonic acid, and containing, when pure, 52·02 per cent. of zinc; but it is frequently rendered impure by admixtures of the carbonates of iron and manganese, peroxide of iron, lime, barytes, clay, electric calamine, cadmium, and other substances.

Crystals of this mineral are rare; it is mostly found in kidney-shaped, botryoidal, stalactitic, cellular, and other imitative shapes. The colour is white, yellowish, grey or brown, with a vitreous lustre, and it is opaque or occasionally translucent.

Calamine occurs in veins, beds, and large deposits termed pockets, and also in lodes, in metamorphic limestone, and in the Devonian, Carboniferous and Oolite formations; and is frequently (as at Altenberg) associated with silicate of zinc (Smithsonite) and Bitter Spar. Large quantities were formerly raised in Northumberland, Cumberland, Derbyshire, and Somersetshire. In the Mendip Hills of the latter county, the ore lies in the Magnesian Conglomerate, and was worked at Shipham, Roborough, near Rickford, and on Broadfield Down. In Derbyshire it is found in carboniferous limestone near Castleton, Wirksworth, and Matlock; in Ireland, in Donegal and Galway, and very largely (in an earthy form) at Silvermines in the county of Tipperary, between the carboniferous limestone and dolomite.

Considerable quantities of Calamine are brought to this country from Spain, where enormous deposits occur for many miles along the north-west coast from Santander into the Asturias, and in Biscay; and from Altenberg or the Vieille Montagne mines, situated in the neutral parish of Moresnet, between Belgium and Prussia. The other chief foreign localities are Tarnowitz and the district of Beuthen in Upper Silesia; Westphalia, at Brilon, and in the neighbourhood of Stolberg in the districts of Aachen and Eupen; Bleiberg and Raibel in Carinthia; Hungary; Siberia; Jefferson county, Missouri; Mexico; China, &c. [HERRERITE.]

According to Dr. Wedding, throughout the States forming the German Commercial Union or Zollverein, Calamine and Blende occur in exactly the same series of geological groups as lead-ores, except that they are absent from the Bunter formation, and are most plentiful in Eifel limestone and the Muschelkalk beds. Calamine is a result of the decomposition of other ores of zinc; in the Black Forest many lead-ores contain Calamine in the upper parts and Blende in the lower.

This ore of zinc is the Smithsonite of Dana, Erdmann, Von Kobell, Haidinger, and some other mineralogists, who, on the other hand, call Smithsonite, or the silicious oxide of zinc, Calamine: a striking instance of the confusion which is caused in mineralogical nomenclature by want of agreement amongst authors.

Calamite (Lat. calamus, *a reed*). A soft translucent kind of Tremolite of an asparagus-green colour, found in rhombic prisms in Serpentine, at Normarken in Sweden.

Calamus (Lat.). The name of a genus of Palms which yields the Canes or Rattans of commerce. These are the produce of *C. Rotang, rudentum, viminalis*, and others, and are used in this country for the bottoms of chairs and couches, the sides of carriages, &c., while in their native countries they are employed in making baskets, mats, hats, and other useful articles. They are also used as ropes or cables in the junks and coasting vessels, and take the place of chains in native suspension bridges. Their thin reed-like stems grow up to a great height amongst other trees, and bear pinnate leaves and long branching flower-spikes. *C. Scipionum* furnishes the walking-sticks known as Malacca canes.

Calamus Aromaticus (Lat.). The rhizome of the *Acorus Calamus*, common over the whole of Europe in moist situations: it is usually known under the name of Sweet Flag. An infusion of the root is a good aromatic tonic. It yields a very small portion of essential oil when distilled with water (scarcely exceeding a thousandth part of its weight), which is used by perfumers.

Calathium or **Calathidium** (Gr. καλάθιον, *a little basket*). A botanical term, employed by some German botanists to denote that kind of depressed contracted inflorescence which is found in composite flowers. It is in reality an umbel with all the flowers sessile.

Calatrava, Order of (in Spain; so denominated from a castle taken from the Moors). Was instituted by Sancho III., king of Castile, in 1158. The kings of Spain are perpetual grand masters of this order of knighthood.

Calc Grit. The name given to a subordinate member of the Oolitic series of rocks in England, lying above and below the coral rag. This rock consists of crushed shells mixed with a large proportion of sand, the whole cemented into a poor gritstone with laminæ of clay, and passing into tough marly rock. [CORAL RAG.]

Calcanthum. Pliny's term for Copperas, or sulphate of iron.

Calcar (Lat. *a spur*). This term is applied by botanists to all hollow prolongations downwards or backwards of leaves or the parts of a flower. The long hollow horns which hang down from one of the sepals of a *Tropæolum*, or from the lip of an *Orchis*, or the curved bodies enclosed within the hood of an Aconite flower, are described by this name.

Calcareous Spar. Crystalline carbonate of lime, composed (when pure) of 44 per cent. of carbonic acid and 56 lime.

It occurs massive, disseminated and crystallised, in numerous forms, all of which are reducible to an obtuse rhombohedron, which is the primary form. The colour is generally white, with a vitreous lustre, but sometimes it is of various shades of grey, red, green, or yellow, owing to an admixture of iron, manganese, bitumen, or other impurities. It passes from perfect transparency to complete opacity. The white transparent varieties are often iridescent.

The purest and most limpid kind of calcareous spar is that procured in Iceland [ICELAND SPAR], which, in common with other transparent varieties, exhibits double refraction to a remarkable degree.

Calcareous spar is a mineral of universal occurrence, found in veins and rocks belonging to every formation, in all parts of the world.

Calcareous Tufa or **Calc Tuff.** A variety of carbonate of lime deposited on and about the margins of waters containing carbonate of lime in solution, in consequence of the evaporation of the water and the escape of carbonic acid. The softer, looser, and more friable kind is generally called *Calcareous Tufa*; the harder and more coherent sort, *Travertine*. The latter (the *Lapis Tiburtinus*, or *Tiber Stone*, of the ancients) is so called because large masses of it abound on the banks of the river of that name. The Coliseum at Rome and the temples of Pæstum are built of this stone. The incrustations of carbonate of lime formed on plants and other objects, by what are called petrifying springs, are deposits of this nature; examples of which are afforded by the springs at Matlock, by those of the cascade of Tivoli in Italy and of many other localities where the same action is going on. Remarkable deposits of this kind are stated by Bischof to occur at Königslutter, near Brunswick, and in the Trieb valley, near Meissen. The calcareous tufa which was deposited in the Roman aqueducts, extending from the heights of the Eifel to Cologne and Trier, is also stated by the same authority to occur in such large masses that columns made from it are found here and there in the churches of the Eifel. Some of the limestones at the lower part of the Purbeck formation have been deposited in the form of tufa; and a mass of calcareous tufa of some extent and thickness has been formed at Blashenwell in Dorsetshire from springs which contain carbonate of lime dissolved out of the Purbeck limestones, and which are still flowing.

Calcedonyx. A variety of Agate in which opaque white Chalcedony or Cacholong alternates with translucent greyish Chalcedony.

Calceolaria (Lat. calceolus, *a small slipper*). A genus of beautiful herbaceous or shrubby plants with yellow, or orange, or purple flowers, the lower half of which is shaped something like an old-fashioned slipper. They naturally inhabit rocks, rich plains, and woods, in Chili, Peru and New Grenada. In this country many of them are hardy enough to live in the open air in summer; and some will even endure our winters, if not very severe. They are, however, all cultivated with most success if regarded as greenhouse plants.

Calciferrite (Lat. calx, *lime*, and ferrum, *iron*). A hydrated phosphate of iron and lime related to Vivianite; found in the form of yellowish nodules in a deposit of clay at Battenberg, in Rhenish Bavaria.

Calcigrade (Lat. calx, *the heel*; gradior, *I walk*). When an animal's heel in walking sinks deeper than the rest of its foot.

Calcination. The reduction of substances to cinder or ash. The term is derived from the Latin word *calx*, quicklime, which, as is well known, is prepared by the action of heat upon limestone; and hence the old chemists employed the word *calcination* to express any supposed analogous change, metallic substances being apparently converted into earthy matter by calcination.

Calcite (Lat. calx, *lime*). A general term under which are comprised the different varieties of carbonate of lime.

Calcium. The metallic base of lime, discovered in 1808 by Davy. This substance has hitherto been obtained in such small quantities, that its properties have not been accurately investigated. It is probably a yellowish, hard, and ductile metal, highly inflammable, and nearly twice as heavy as water. Combined with oxygen it forms lime, which consists of 20 calcium + 8 oxygen = 28 lime.

Calculating Machine. A piece of mechanism for assisting the human intellect in the performance of arithmetical operations. Amongst the various machines which have been invented for this object, the two devised by Mr. Babbage, but never fully executed, are by far the most elaborate. Descriptions of these, and much general information on the subject, will be found in Mr. Babbage's *Passages from the Life of a Philosopher*, London 1864, and in his forthcoming *History of the Analytical Engine*.

Calculation, Calculus (Lat. calculus, *a small pebble*, the Romans having made use of pebbles in casting up accounts). In modern language, the term *calculus* is employed to denote any branch or any operation of mathematics which requires or may involve numerical calculation; and therefore may be applied to the whole of the mathematical sciences, excepting pure geometry. Thus that part of algebra which treats of exponents is called the *exponential calculus*. In like manner the phrases *calculus of definite integrals, calculus of functions, calculus of variations*, &c., are used to denote certain branches of the higher mathematics. [DIFFERENTIAL CALCULUS; INTEGRAL CALCULUS; VARIATIONS.]

Calculus (Lat.). In Physiology, the general term for inorganic concretions of various kinds, formed in various parts of the body, and bearing in shape or composition a general resemblance to stones. The term *calculus* is, however, generally confined to urinary concretions.

Caldarium (Lat.). In ancient Architecture, by some authors used in the sense of Laconicum; it was an apartment in a bath heated for the purpose of causing perspiration. Vitruvius, however, uses the word to signify a hot bath.

Calderite. A massive variety of Garnet found in Nepal.

Caledonite. A cupreous sulpho-carbonate of lead, found in minute bluish green crystals, associated with other ores of lead, at Leadhills in Lanarkshire and at Roughten Gill in Cumberland. It is, also, said to occur in the Harz, and at Mine la Motte in Missouri.

The word Caledonite, derived from *Caledonia*, has reference to the locality where the mineral was originally discovered.

Calembour. A French expression for what in English is called a pun. A certain Westphalian Count Calemberg (Kahlenberg), who visited Paris in the reign of Louis XV., and was famous for his blunders in the French language, is said to have given the name to this species of jeu de mots.

Calendar (Lat. calendarium). A distribution or division of time into periods adapted to the purposes of civil life; also a table or register of such divisions, exhibiting the order in which the seasons, months, festivals, and holidays succeed each other during the year. The word is derived from the ancient Latin verb *calare*, to call. In the early ages of Rome, it was the custom for the pontiffs to call the people together on the first day of each month, to apprise them of the days that were to be kept sacred in the course of it. Hence *dies calendæ*, the calends or first days of the different months.

The calendars in use throughout Europe are borrowed from that of the Romans. Romulus is supposed to have first undertaken to divide the year in such a manner that certain epochs should return periodically after a revolution of the sun; but the knowledge of astronomy was not then sufficiently advanced to allow this to be done with much precision. According to the legend, he placed the commencement of the year in spring, and divided it into ten months—March, April, May, June, Quintilis, Sextilis, September, October, November, and December. March, May, Quintilis, and October contained thirty-one days each; the other six contained only thirty. The names Quintilis and Sextilis remained in the calendar till the end of the republic, when they were changed into July and August; the former in flattery of Julius Cæsar, and the latter of Augustus.

According to the mythical history, the year of Romulus contained only 304 days. Numa, it is said, added two months; January to the beginning of the year, and February to the end. About the year 452 B.C. this arrangement was changed by the Decemvirs, who placed February after January; since that time the order of the months has remained undisturbed. In Numa's year the months consisted of 29 and 30 days alternately, to correspond with the synodic revolution of the moon. The year would therefore consist of 354 days; but one day was added to make the number odd, as being more lucky. In order to produce correspondence with the solar year, Numa ordered an intercalary month to be inserted every second year between the 23rd and 24th of February, consisting alternately of 22 and 23 days. Had this regulation been strictly adhered to, the mean length of the year would have been 365¼ days, and the months would have continued for a long time to correspond with the same seasons. But a discretionary power over the intercalary month was exercised by the pontiffs, who frequently abused it for the purpose of hastening or retarding the days of the election of magistrates: and the Roman calendar continued in a state of uncertainty and confusion till the time of Julius Cæsar, when the civil equinox differed from the astronomical by three months. (For a critical examination of the traditions relating to the early Roman calendar, the reader is referred to Sir G. C. Lewis's *Astronomy of the Ancients*, ch. i.)

Under the advice of the astronomer Sosigenes, Cæsar abolished the lunar year, and regulated the civil year entirely by the sun. He decreed that the common year should consist of 365 days; but that every fourth year should contain 366. In distributing the days among the different months, he ordered that the odd months, that is, the first, third, fifth, seventh, ninth and eleventh, should contain each 31 days, and the other months 30, excepting February, which in common years was to contain only 29 days, but every fourth year 30 days. This natural and convenient arrangement was interrupted to gratify the frivolous vanity of Augustus, by giving August, the month named after him, an equal number of days with July, which was named after the first Cæsar. The intercalary day, which occurred every fourth year, was inserted between the 24th and 25th of February. According to the peculiar and awkward manner of reckoning adopted by the Romans, the 24th of February was called the sixth before the calends of March, *sexto calendas*. In the intercalary year this day was repeated, and called *bis-sexto calendas*; whence the term *bissextile*. The corresponding English term, *leap year*, appears less correct, as it seems to imply that a day was *leapt* over instead of being thrust in. It may be remarked, that in the ecclesiastical calendar the intercalary day is still inserted between the 24th and 25th of February.

The Julian year consisted of 365¼ days, and consequently differed in excess by 11 minutes 10·35 sec. from the true solar year, which consists of 365 d. 5 h. 48 m. 49·62 sec. In consequence of this difference the astronomical equinox, in the course of a few centuries, fell back sensibly towards the beginning of the year. In the time of Julius Cæsar it corresponded to the 25th of March; in the sixteenth century it had retrograded to the 11th. The correction of this error was one of the

purposes sought to be obtained by the reformation of the calendar effected by Pope Gregory XIII. in 1582. By suppressing 10 days in the calendar, Gregory restored the equinox to the 21st of March, the day on which it fell at the time of the council of Nice in 325; the place of Easter and the other movable church feasts in the ecclesiastical calendar having been prescribed at that council. And in order that the same inconvenience might be prevented in future, he ordered the intercalation which took place every fourth year to be omitted in years ending centuries; that is to say, on the 100th, 200th, &c.; excepting on the 400th and the years which are multiples of 400. The Gregorian rule of intercalation may therefore be expressed as follows:—

'Every year of which the number is divisible by 4 without a remainder is a leap year, excepting the centesimal years, which are only leap years when divisible by 4 after suppressing the two zeros.' Thus 1600 was a leap year; 1700 and 1800 were common years; 1900 will be a common year, 2000 a leap year, and so on.

The Gregorian method of intercalation thus gives 97 intercalations in 400 years; consequently 400 years contain $400 \times 365 + 97 = 146097$ days, and therefore the length of one year is 365·2425 days, or 365 d. 5 h. 49 m. 12 sec., which exceeds the true solar year by 22·38 sec., an error which amounts only to one day in 3,866 years.

If an astronomer were required, without any reference to established usages, to give a rule of intercalation by which the commencement of the civil year, while it always coincided with the commencement of a day, should deviate the least possible from the same instant of the solar year, he would proceed as follows: The length of the mean solar year being 365·242241 days, the excess above a whole number of days is ·242241, which converted into a continued fraction becomes:

$$\cfrac{1}{4+\cfrac{1}{7+\cfrac{1}{1+\cfrac{1}{4+\cfrac{1}{7+\cfrac{1}{1+, \&c.}}}}}}$$

Whence the following series of approximate fractions is derived:

$$\frac{1}{4},\ \frac{7}{29},\ \frac{8}{33},\ \frac{39}{161},\ \frac{281}{1160},\ \frac{320}{1321},\ \&c.$$

Of these the first gives an intercalation of 1 day in 4 years, which supposes the year to be 365¼ days. The second gives 7 intercalations in 29 years, and supposes the length of the year to be 365 d. 5 h. 47 m. 35 sec., which is somewhat too small. The third fraction, $\frac{8}{33}$, is remarkable, as giving a year which differs in excess from the true solar by 15·38 seconds; so that by intercalating 8 times in 33 years, or 7 times successively at the end of every fourth year, and once at the end of the fifth year, the difference between the civil and solar year would only accumulate to a day in about 5,600 years, while in the Gregorian calendar the error amounts to a day in 3,860 years. Nevertheless the Gregorian rule has this advantage, that leap year is always readily distinguished.

The Gregorian calendar was received immediately or shortly after its promulgation by all the Roman Catholic countries of Europe. The Protestant states of Germany, and the kingdom of Denmark, adhered to the Julian calendar till 1700; and in England the alteration was successfully opposed by popular prejudices till 1752. In that year the Julian calendar, or *old style*, as it was called, was formally abolished by Act of Parliament, and the date used in all public transactions rendered coincident with that followed in other European countries, by enacting that the day following the 2nd of September of the year 1752 should be called the 14th of that month. When the alteration was made by Gregory it was only necessary to drop 10 days; the year 1700 having intervened, which was a common year in the Gregorian but a leap year in the Julian calendar, it was now necessary to drop 11 days. The old style is still adhered to in Russia and the countries following the communion of the Greek church; the difference of date in the present century amounts to twelve days.

Ecclesiastical Calendar.—The adaptation of the civil to the solar year is attended with no difficulty; but the church calendar for regulating the movable feasts imposes conditions less easily satisfied. The early Christians borrowed a portion of their ritual from the Jews. The Jewish year was luni-solar: that is to say, depended on the moon as well as on the sun. Easter, the principal Christian festival, in imitation of the Jewish passover, was celebrated about the time of the full moon. Differences of opinion, and consequently disputations, soon arose as to the proper day on which the celebration should be held. In order to put an end to an unseemly contention, the council of Nice laid down a specific rule, and ordered that Easter should always be celebrated on the Sunday which immediately follows the full moon that happens upon, or next after, the day of the vernal equinox. In order to determine Easter according to this rule for any particular year, it is necessary to reconcile three periods; namely, the week, the lunar month, and the solar year. To find the day of the week on which any given day of the year falls, it is necessary to know on what day of the week the year began. In the Julian calendar this was easily found by means of a short period or cycle of 28 years [CYCLE], after which the year begins with the same day of the week. In the Gregorian calendar this order is interrupted by the omission of the intercalation in the last year of the century. But to render any calculation unnecessary, a table is given in the prayer-books, showing the correspondence of the days of the year and the week for the

current century. [DOMINICAL LETTER.] The connection of the lunar month with the solar year is an ancient problem, for the resolution of which the Greeks invented cycles or periods, which remained in use with some modifications till the time of the Gregorian reformation. [METONIC CYCLE; GOLDEN NUMBER.] The author of the Gregorian calendar, Luigi Lilio Ghiraldi, or, as he is frequently called, Aloysius Lilius, employed for the same purpose a set of numbers called Epacts (for an explanation of the use of which, see EPACT). It is to be desired that this complicated system of rules and tables were rendered unnecessary by abolishing the use of the lunar month, and causing Easter to fall invariably on the same Sunday of a calendar month; for example, on the first or second Sunday of April.

New French Calendar.—A new reform of the calendar was attempted to be introduced in France during the period of the Revolution. The commencement of the year was fixed at the autumnal equinox, which nearly coincided with the epoch of the foundation of the republic. The names of the ancient months were abolished, and others substituted having reference to agricultural labours, or the state of nature in the different seasons of the year. But the alteration was found to be inconvenient and impracticable, and after a few years was formally abandoned. [CYCLE; ERA; HEJIRA; YEAR.]

Calender (Fr. calandre, Lat. cylindrus, Gr. κύλινδρος). A machine for pressing and smoothing cloth and other articles, which when so prepared are said to be *calendered*.

Calends (Lat. calendæ). In the ancient Roman calendar, were the first days of each month. The Roman month was divided into three periods by the *Calends*, the *Nones*, and the *Ides*. The *Calends* were invariably placed at the beginning of the month; the *Ides* at the middle of the month, on the 13th or 15th; and the *Nones* (*novem*, nine) were the ninth day before the Ides, counting inclusively. From these three terms the days were counted backwards, in the following manner: Those days comprised between the calends and the nones were denominated *days before the nones*; those between the nones and the ides, *days before the ides*; and those from the ides to the end of the month, *days before the calends*. Hence the phrases *pridie calendas*, *tertio calendas*, &c.; meaning the second day before the calends, or last day of the month, the third day before the calends, or last but one of the month (the *calends* or first day of the following month being included in the reckoning), and so on. In the months of March, May, July, and October, the ides fell on the 15th day, and the nones, consequently, on the 7th. In all the other months the ides fell on the 13th, and the nones, consequently, on the 5th. The number of days receiving their denomination from the calends depended on the number of days in the month and the day on which the ides fell. For example, if the month had thirty-one days, and the ides fell on the 13th (as happened in January, August, and December), there would remain eighteen days after the ides, which, added to the first of the following month, made nineteen days of calends. Hence the 14th day of January was styled the *nineteenth before the calends* of February; the following day, or 15th of the month, was *the eighteenth before the calends*, and so on.

Calendulin. A mucilaginous substance or species of gum obtained from the marigold.

Calenture (Lat. caleo). A delirious fever, produced by the sun, in which it is common for the patient to imagine the sea to be green fields.

Calibre (Fr.). The calibre of a gun is the diameter of its bore. It is measured in terms of inches, and in smooth-bored guns is always rather larger than the diameter of the shot. [WINDAGE.]

Calico Printing. The art of producing figured patterns upon calico; they are transferred to its surface by blocks, copper plates, or engraved cylinders, by which the colours are directly printed, or by which *mordants* are so applied that when the calico is immersed in a colouring bath, the colour adheres or is produced only upon the parts to which the mordant has been previously applied. [DYEING.]

Caliduct (a word coined from the Latin calor, *heat*, and duco, *I lead*). A pipe, or flue, from a source of heat, for the distribution of the same in an apartment or house.

Caligidæ. A family of parasitic Entomostracous Crustaceans, belonging to the order *Siphonostoma*, characterised by having the mouth organised for piercing and suction. The parasites of this family prey almost exclusively upon fish, and are commonly called fish-lice. Gold-fish are sometimes infested to an almost incredible extent with a species, the *Monoculus foliaceus* of Linnæus, which is nearly a quarter of an inch long, having the body covered with a broad round transparent shield, notched behind to give free motion to the tail. The first pair of legs are shaped like a cupping-glass, for the purpose of holding on; the last four pairs are formed for swimming, and terminated each by two long and feathered filaments, probably subservient to respiration.

Caliper Compasses (or simply Calipers). Are compasses with curved legs, for measuring the calibre (whence the name) or diameter of cylinders, balls, or other round bodies. Calipers of the best sort are made with a scale having different sets of numbers engraved on it, like a sliding rule, for the purpose of exhibiting at once various relations depending on the magnitude of the diameter of the body measured. Thus, as the weights of balls of the same metal are in a constant ratio to the cubes of their diameters, the scale may be so graduated and numbered that the observer may read off either the diametor in inches or the weight in pounds. Other numbers having a less immediate application are also frequently attached: for example, the degrees of a circle, the proportions of troy

and avoirdupois weight, tables of the specific gravities and weights of bodies, &c. It is obvious that these may be varied infinitely, according to the purposes proposed to be accomplished.

Caliph (Arab. khalifah). Originally a deputy or lieutenant, but afterwards applied chiefly to the successors of Mohammed. As representatives of the prophet of Islam, the caliph exercised a power which was primarily spiritual; and in theory therefore he claimed the obedience of all Mohammedans. In practice the claim was soon disregarded; and the Fatimite caliphs of Africa and the sovereigns of the Ommiad dynasty of Spain each professed to be the only legitimate representatives of Mohammed, in opposition to the Abasside caliphs of Bagdad. The latter caliphat reached its highest splendour under Haroun al Raschid in the ninth century; but his division of the empire among his sons showed how completely the caliph had lost sight of the spiritual theory of his office. For the last two hundred years the appellation of caliph has been swallowed up in *Shah*, *Sultan*, *Emir*, and other titles peculiar to the East.

Calippic Period. In Ancient Chronology, is a correction of the Metonic cycle proposed by Calippus. The Metonic cycle was a period of nineteen solar years, at the end of which time the new moons return again on the same days of the year. The period contained exactly 6,940 days. Now 6,940 days exceeds 235 lunations by only seven hours and a half. At the end of four cycles, or 76 years, the accumulated excess of 7½ hours amounts to one whole day and six hours. Calippus therefore proposed to quadruple the period of Meton, and to deduct a day at the end of it by changing one of the months of 30 days into a month of 29 days. [METONIC CYCLE.] The period of Calippus is sometimes referred to as a date by Ptolemy.

Calixtines. One division of the Bohemian Reformers, who in the fifteenth century protested against the errors of the church of Rome, and maintained their independence by force of arms. After the death of Huss, his followers split into two principal parties, under the names of Taborites and Calixtines; of which the latter were the most moderate and held out chiefly on the ground of the refusal of the cup (calix) to the laity, whence they derived their name. Their hostility was at length propitiated by indulgence on this point: the church of Rome declaring expressly at the same time that the giving or withholding of the sacramental wine is a matter of ecclesiastical ordinance merely, and neither the one nor the other essential to the reception of the benefits of the eucharist. The council of Basle (1431) says: 'Sive sub unâ specie sive duplici quis communicat, secundum ordinationem seu observationem ecclesiæ, proficit dignè communicantibus ad salutem.'

The same name is given to the followers of George Calixtus, a German divine of the seventeenth century, who proposed a reconciliation between the Roman Catholics, Lutherans, and Reformed church, on the basis of the Apostles' Creed. (Hallam's *Literary History*, part iii. ch. ii.)

Callais. The name which Damour proposes to apply to a hydrated phosphate of alumina, some personal ornaments made of which have been lately discovered in a Celtic tomb in the west of France, at Lockmariaquer in the department of Morbihan. The mineral is a species of Turquoise, nearly as translucent as Chrysoprase, and of an apple-green colour approaching to emerald-green, which appears to be produced by iron and not by copper.

This stone answers to Pliny's description of the Callais, which has been considered by modern mineralogists to be the Oriental Turquoise (hence called Callaïte), a name which Damour proposes to apply only to the precious stone of a sky-blue colour, which is so much used in jewellery.

Callaite. [TURQUOISE.]

Calligraphy (Gr. καλλιγραφία). The art of beautiful writing. The scribes who made a profession of copying manuscripts before the invention of printing have been termed Calligraphers. Their art consisted not merely in writing, but also in embellishing their work with ornamental devices, although ILLUMINATION [which see] was also practised as a distinct employment. Among the MSS. of the early part of the middle ages which we possess, there are some sumptuous specimens of the art, written in letters of gold, vermilion, &c., and on leaves of different colours, but that fashion went early out of use; and in general it may be said, that the current writing of calligraphers diminished in beauty and in laborious minuteness, especially in Italy, during the centuries immediately preceding the invention of printing.

Callionymus (Gr. καλλιώνυμος, *with beautiful name*). A genus of beautifully spiny-finned fishes, with very small gill-openings; ventral fins under the throat, and larger than the pectorals; head oblong, flattened; eyes placed near to each other, and directed upwards; no teeth on the palate; intermaxillaries capable of considerable protrusion. They have no air-bladder. The gemmeous or golden dragonet (*Callionymus lyra*) is a British example of this genus.

Calliope (Gr. *beautiful-voiced*). In Mythology, the Muse of epic or heroic poetry.

Callitrichaceæ (Callitriche, the only genus). A small cluster of imperfectly organised water-plants, with opposite leaves and minute unequal axillary flowers so reduced in structure as to afford little indication of their affinity, and hence their position remains unsettled. By some they are considered allies of *Haloragaceæ*, by others of *Urticaceæ*; it has also been proposed on plausible grounds that they are a reduced form of *Euphorbiaceæ*.

Callitris. A genus of *Coniferæ*, related to *Thuja*, from which it is known by the cones consisting of from four to six woody scales, which separate one from the other, each scale

having from three to six winged seeds. *C. quadrivalvis*, a large tree of Barbary, yields a very hard, almost indestructible fragrant wood, and also the aromatic gum resin called Sandarach.

Callorhynchus. [CHIMÆRA.]

Callow. The top or rubble-bed of a quarry of stone, or ballast, which is obliged to be removed before the material is raised; it is the great source of expense in working a quarry.

Callus. In Osteology, the matter which unites the divided ends of broken bones: it is a secretion of new bony matter.

Calomel. The old chemical name of *chloride of mercury*. The word is perhaps derived from the Greek κάλος, *fair*, and μέλας, *black*. It is prepared by rubbing mercury with corrosive sublimate, which forms a *black* mixture, which, by the application of heat, yields a *white* sublimate of calomel. It is much used in medicine, especially as a purgative. It consists of 200 mercury + 36 chlorine = 236 chloride of mercury or calomel. Calomel is also found *native*, but it is a rare mineral.

Calophyllum (Gr. καλλίφυλλος, *with beautiful leaves*). The East Indian Tacamahac, a greenish coloured resin, exudes from the trunk of *C. inophyllum*, a species of this genus of *Clusiaceæ*, which consists of large shining-leaved tropical trees. The timber of this species is also used for building purposes, and for masts and spars; and its seeds yield a strong-scented oil used in India for lamps. In the West Indies, a similar oil is obtained from the Calaba (*C. Calaba*), a tree producing short racemes of white sweet-scented four-petaled flowers. Other species yield edible fruits, timber, and oil.

Caloric (Lat. calor, *warmth*). A term applied by the French chemists to designate *the matter of heat*, it being assumed that the phenomena of heat are dependent upon the presence of a highly attenuated, mobile, and imponderable form of matter. [HEAT.]

Calorifacient (Lat. calor, *heat*; facio, *I make*). The term is applied in Physiology to those non-azotised materials of food, in the form of fat, starch, sugar, and gum, which are believed to be employed in the production of heat.

Calorific Rays. A term applied to the invisible heating rays which emanate from the sun, and from burning and heated bodies.

Calorimeter (Lat. calor, *heat*, and metrum, *a measure*). An instrument for measuring the quantity of heat given out by bodies in passing from one temperature to another.

Calorimotor (Lat. calor, *heat*, and moveo, *I put in motion*). This term has occasionally been applied to a peculiar form of the voltaic apparatus composed of one pair of plates of great extent of surface, the electricity of which, when transmitted through good conductors, produces intense heat.

Calosoma (Gr. καλός, *beautiful*; σῶμα, *body*). A genus of most splendid Coleopterous insects, belonging to the family *Carabidæ*, or ground-beetles. In this genus the jaws are toothless, or rather devoid of notches; the maxillary palpi terminate in a large joint, and the abdomen is broad. There are two British species: *Calosoma sycophanta*, so called because its grub insinuates itself into the nests of gregarious caterpillars, and feeds upon them; and *Calosoma inquisitor*. In speculating on the exception which the Calosomes present among the *Carabidæ* in the brilliant colours which are developed in them, an explanation seems to be afforded by a difference in their habits: they frequent trees, and are more exposed to the light than their hole-and-corner congeners, the ground-beetles.

Calotropis (Gr. καλός, and τροπίς, *a keel*). A genus of *Asclepiadaceæ*, consisting of shrubs or small trees, common in India. One of them, *C. gigantea*, is the Mudar, the inner bark of whose branches yields a very strong valuable fibre, and whose milky juice in the fresh state is a valuable remedy in cutaneous diseases, and at length hardens into a substance resembling gutta percha. *C. procera*, a smaller plant, possesses similar properties.

Calotype or **Kalotype** (Gr. καλός, and τύπος). A term applied to the photogenic drawings obtained by the action of light upon certain salts of silver. [PHOTOGRAPHY.]

Caloyers (Mod. Gr. καλόγερος). Monks of the Greek Church, who follow the rule of St. Basil.

Calp. In Geology, a name given to a peculiar and impure limestone, found occasionally in rocks of the Devonian and carboniferous series in Ireland.

Calumba. The root of the *Jateorhiza palmata*. It is dried in slices of a yellowish grey colour, and is generally worm-eaten. It has a bitter and slightly pungent taste, and is very mucilaginous. Calumba root is an excellent tonic medicine.

Calumet. In Modern History, a large beautifully adorned pipe, used by the North American Indians as the emblem of peace. The first notice of the calumet among European writers is to be found in Ferdinand de Soto's account of his expedition through the southern provinces in 1470.

Calvary. A sculptural representation of the passion of the Saviour, placed upon a natural or an artificial rock, or upon an architectural base.

Calvinists. The followers of Calvin, the second great reformer of the sixteenth century, and founder of the church of Geneva. The distinguishing tenets of this celebrated theologian refer to points both of discipline and doctrine. He was the first to reject the episcopal form of church government, originally, it is said, with great reluctance, and compelled thereto by the want of regularly ordained ministers; but he afterwards maintained the exclusive divine appointment of the Presbyterian system, which has since obtained favour in Scotland, and among the Protestants of France, and has had numerous adherents in this country and America. The doctrinal opinions of Calvin,

however, have not been permanently received among those who have adopted his views respecting the ministry. On the contrary, in England and Geneva, there are many Presbyterians Arminian in sentiment. It was at the synod of Dort, in 1618, that the points in dispute between the Calvinists and Arminians were most accurately distinguished, and arranged under five heads, upon which the former party asserted the following opinions:—

1. Of predestination—that all men have sinned in Adam, and are become liable to the curse; but that God has by an eternal decree chosen some from the beginning, to whom He should impart faith of His free grace, and consequently salvation.

2. Of the death of Christ—that it is a sufficient sacrifice for the sins of the whole world; and the fact that some only believe and are saved, whereas many perish in unbelief, arises not from any defect in this sacrifice, but from the perversity of the non-elect.

3. Of man's corruption—that all men are conceived in sin and born the children of wrath, and are neither willing nor able to return to God without the aid of the Holy Spirit.

4. Of grace and free will—that the influence of the Spirit upon our fallen natures does not force, but only quickens and corrects them, inducing them gently to turn themselves towards God by an exercise of their free will.

5. Of perseverance—that God does not wholly take away His Spirit from His own children, even in lamentable falls; nor does He permit them to fall finally from the grace of adoption and the state of justification.

These opinions, which were laid down at the synod of Dort, represent the sentiments of the founder of this school, and of the ancient or *strict* Calvinists. In modern times another class of *moderate Calvinists* has arisen, who differ from these in holding lower notions concerning reprobation and the extent of Christ's sacrifice. For other subdivisions among the Calvinists, see SUB-LAPSARIANS and SUPRA-LAPSARIANS.

Calx (Lat.). A name applied by the alchemists to products of combustion, especially those obtained from the metals, which were supposed to be converted into a species of *earth*.

Calybio. The name adopted by some carpologists for such a one-celled, inferior, one or few seeded fruit, enclosed in a cupule, as the acorn of the oak, the mast of beech, &c.

Calycanthaceæ (Calycanthus, one of the genera). A small natural order of plants related to *Rosaceæ*, from which they are distinguished by their imbricated sepals, and partly sterile, partly fertile anthers being turned outwards. The Carolina Allspice, *Calycanthus floridus*, used as a substitute for cinnamon, is one of them. They are all shrubs with fragrant flowers, and inhabit North America or Japan. Some of them resemble the genus *Illicium* in their flowers.

Calyceraceæ (Calycera, one of the genera). A natural order of plants related to *Compositæ*, from which they differ very little, excepting that their seeds are pendulous and albuminous, and their anthers half united. The species are woody herbaceous plants, inhabiting the warmer parts of South America.

Calyculus. A diminutive of CALYX [which see].

Calymene (Gr. κεκαλυμμένη, *concealed*). A name devised to express the obscure nature of a genus of Trilobites (fossil crustaceans), to which it is attached, and which is distinguished from all other Trilobites by the faculty which the species possesses of rolling the body up into the form of a ball, in the same manner as the recent genera *Sphæroma*, *Armadillo*, *Glomeris*, viz. by approximating the two extremes of the trunk at the under part. The anterior segment or shield of Calymene is as broad as or broader than it is long, and supports two compound prominent eyes; the posterior or terminal segment forms a sort of triangular elongate tail.

Calypso (Gr. Καλυψώ). In Mythology, a daughter of Atlas according to Homer, but of Oceanus and Tethys according to Hesiod, was the queen of the island Ogygia. On this island Ulysses suffered shipwreck; and Calypso, in spite of his desire to return home to Ithaca, detained him there seven years, till, warned by Hermes, she was compelled to let him go.

Calyptolite. An altered Zircon, occurring in minute short square prisms, of a dark brown or greenish brown colour, at Haddam and Middletown, in Connecticut.

Calyptræa (Gr. καλύπτρα, *a covering*). The name of a genus of Gastropods, having a patelliform shell, to the concavity of which adheres either a smaller conical shell, like a cup in a saucer, or a semicircular testaceous process, forming the commencement of a columella. The branchiæ consist of a single row of long and slender filaments. The foot is circular, expanded, and furnished with two anterior processes. The genus, originally established by Lamarck, forms the family Calyptræidæ, composed of the genera Calyptræa, Crepidula, Pileopsis, Metoptoma, Platyceras, Hipponyx, and Phorus.

Calyx (Gr. κάλυξ, *a cup*). In Anatomy, is applied to that branch of the pelvis of the kidney which receives the apex of the cone or bundle of the uriniferous tubules: in man there are several 'calyces' in the kidney.

In Botany, the name given to the outermost of the enveloping organs of a flower. It is usually green, and sometimes bears a great resemblance to leaves; but it is also frequently richly coloured, as in the *Mirabilis*, *Salvia splendens*, &c. This organ appears to have the office of protecting the more tender parts lying within it, and is therefore usually present in flowers; when absent, its protecting office is always performed by some modification of bracts, as in the Arum and the Willow. If it is adherent to the sides of the ovary, it is called

superior; if partially adherent, half superior; and if quite free from the sides of the ovary, it is inferior. In systematical botany these differences are of great importance.

Cam or Camb. In Machinery, a contrivance for converting a uniform rotatory motion into a varied rectilinear motion. The end of a rod which is free to move only in the direction of its length is held in contact, by the action of a spring, or weight, with the edge of an irregularly shaped mass which revolves uniformly upon an axis. A varied motion is thus communicated to the rod, which carries with it the machinery by which the motion is to be applied. This contrivance is much used in the machinery for lace-making. [Ross Engine.]

Cam-wood. The wood of *Baphia nitida*: the tree which yields it grows in Sierra Leone and the interior of Africa. It is used in dyeing instead of Brazil-wood, and gives a finer and more durable red.

Camaldulians or Camaldulites. An order of monks, under the rule of St. Benedict, founded at Camaldoli, in the Tuscan Apennines, in the eleventh century.

Camarilla (Span.). The *little* or private chamber of the sovereign of Spain (equivalent to the *petits appartements* of the old French régime); but the term is generally applied to his immediate confidants, who are usually all-powerful in the government of the country. In England the term is nearly synonymous with *clique*.

Camassia (Quamash or Kamas, its native name in America). A genus of *Liliaceæ*, the only species of which, *C. esculenta*, is the Quamash of the North American Indians. It bears a close resemblance to *Scilla*, having blue expanded flowers, which, however, are somewhat irregular in form. It grows in abundance on the swampy plains of the north-west parts of America; and the bulbs, which form the greater part of the vegetable food of the Indians, are there collected soon after the flowering period, a labour which devolves principally on the women. They are cooked by baking in a hole dug in the ground, and are then pounded and dried into cakes for future use.

Camber (Fr. cambre). The small rise which is given to a piece of framing, a roof, or an opening of any kind in a building, for the purpose of compensating for the settlement of the various parts, or for the necessary subsidence of the joints, is known by the name of *camber*. It is given in order to prevent the beam or the piece of timber or stone from becoming concave on the upper surface, either by its own weight or by the load it may have to carry.

Camber. In Shipbuilding, signifies a curvature upwards. A deck is said to be cambered when higher amidships than at the bow or stern. Camber is, likewise, the name for a small dock for boats and timber.

Cambium (a Low Latin word for liquid which becomes glutinous). A viscid secretion formed between the liber and alburnum of Exogenous trees in the early spring, when vegetation recommences. It is supposed by some physiologists to be the matter out of which new wood and bark are formed; by others to be a preparation of organisable matter, out of which the horizontal growth of the cellular system, and the vertical growth of the woody system, may be nourished during their respective developement. It disappears as soon as the new wood and bark have been completely formed.

Cambogia (Cambodja, a district whence gamboge was procured). The name under which the plant yielding gamboge was formerly known. It is now more generally called *Hebradendron gambogioides* or *Garcinia Cambogia*.

Cambrian Series. The earliest fossiliferous rocks in North Wales were thus named by Professor Sedgwick many years ago. They are regarded as forming a natural basis of the Silurian series, but include also the lower member of that series. However convenient it may be found to distinguish locally between the various parts of one great series, there are no grounds for making these subdivisions the basis of general classification, and thus the Cambrian has generally been regarded as a subordinate member of the Silurian group. The determination of very large series of sedimentary rocks of much greater geological age than either Silurian or Cambrian has modified the views of geologists as to the importance of these subdivisions.

Cambric. A delicate linen fabric, which was originally manufactured at *Cambray*.

Camel. A machine invented by the Dutch for carrying vessels into harbours where there is not a sufficient depth of water. It consisted of two large boxes, or half-ships, built in such a manner that they could be applied on each side of the hull of a large vessel. On the deck of each part of the camel a number of horizontal windlasses were placed, from which ropes proceeded on one side, and being carried under the keel of the vessel, were attached to the windlasses on the deck of the other part. When about to be used, as much water as necessary was suffered to run into them; all the ropes were then cast loose, and large beams were placed horizontally through the port-holes of the vessel, the ends resting on the camels alongside. When the ropes were made fast, and the vessel properly secured, the water was pumped out, on which the camels rose and bore up the vessel. (Beckman's *History of Inventions*, vol. iii. p. 337.)

Camel. In Zoology. [Camelidæ.]

Cameleon or Chamæleon Mineral. Manganesate of potash, obtained by melting a mixture of potash and black oxide of manganese. When put into water the solution is first green, and passes through a variety of tints of green, purple, and red, till at length it becomes colourless.

Cameleon. In Zoology. [Chamæleon.]

Camelidæ (Gr. κάμηλος). A family of ruminant Mammalia, which deviates from the rest of the order in the presence of two incisors in the upper jaw, and the absence of

cotyledons in the uterus and fœtal membranes. The camel and dromedary of the Old World, and the llama, guanaco, and vicuña of the New World, are the existing species of this family.

The Old-World Camelidæ (*Camelus*) are especially organised for existence in the arid and barren deserts of Asia and Africa. They have a broad, expanded, elastic foot, terminated in front by two comparatively small hoofs, and well defended beneath by a felt of coarse hair. The New-World Camelidæ (*Auchenia*) have narrower feet, and the hoofs are bent in the form of claws, adapted to climb the steep passes of the mountain ranges of South America, to which continent they are confined.

Besides the peculiar characters above mentioned, the camels present a modification in the structure of the stomach which is not present in any other family of Ruminantia. There are developed from the sides of the first cavity of the stomach or paunch two series of cells, into which experiment has proved that the water which the animal drinks almost exclusively passes, and where it can be kept apart from the solid contents of the paunch in a quantity of several quarts. Surely the final relation of such a modification of structure to the peculiar physical characteristic of the localities to which the animal possessing it is confined must force itself irresistibly on the mind. But besides a reservoir of water to meet the exigences of long journeys across the desert, the dromedary and camel are provided with a storehouse of solid nutriment on which they can draw for supplies long after every digestible part has been extracted from the contents of the stomach: this storehouse consists of one or two large collections of fat stored up in ligamentous cells supported by the spines of the dorsal vertebræ, and forming what are called the humps. When the camel is in a region of fertility the hump becomes plump and expanded; but after a protracted journey in the wilderness it becomes shrivelled and reduced to its ligamentous constituent, in consequence of the absorption of the fat. Buffon carried his teleological reasoning, or the ascription of design, so far as to assert that the humps on the backs of the camel were badges of slavery, and intended to adapt them to the burdens of their taskmasters; and he supported this ingenious idea by the unfounded assertion that the dorsal prominences did not belong to the camels in free nature. But the true uses of the fatty humps, as of the water-cells, relate to the exigences of the Camelidæ of the deserts under every condition. The complete adaptation of the camel for the dreary wastes in which it is destined to exist, is further illustrated by some minor modifications in its structure. The nostrils are narrow oblique slits, defended with hair at their margins, and provided with a sphincter muscle, like the eyelids; so that the animal can close them at pleasure. This action is of great service in excluding the fine and penetrating sand which is drifted along in clouds by the storms of the desert. The expanded sole of the foot, elastic as a cushion, prevents the leg from sinking in the loose surface: the long joints and lofty tread of the camel are equally adapted for a rapid progression along loose sandy plains. Thus to the Arab of the scorching desert the camel is as valuable, and indeed as essential, as the reindeer to the Laplander in his region of perpetual snow. The one animal, like the other, serves, while living, for all the purposes of draught and burden, and supplies his master's family with milk. When dead, the flesh of the camel is eaten, though it is coarser than that of the ordinary Ruminants: its hide, which approaches that of the Pachyderms in thickness and strength, is applied to the manufacture of saddles, harness, pitchers, shields, and various other articles. The finer hair is manufactured into articles of clothing, and the coarser hair is woven into a kind of matting for the covering of tents. By day the camels transport their owner and his family, with all their property, from place to place. By night the body of the recumbent beast of burden serves as a pillow for his master; or if the air be agitated, the camels are arranged to windward, so as to form a barrier against the ever-shifting sands.

The camel is the sole medium of communication between those countries which are separated by extensive deserts; in the beautiful and expressive metaphor of eastern speech, it is 'the ship of the desert,' and in truth it is the only ship by which the wilderness can be navigated with certainty and safety. A stout Arabian camel can travel with a load of 800 pounds at the rate of about three miles in the hour. The swifter varieties, as the light dromedary or 'mahairy,' are said to carry a single rider over a space of from 70 to 100 miles in 24 hours, and that for several days in succession.

Camelina (Gr. χαμαί, *on the ground*; λίνον, *flax*). A cruciferous genus, one species of which, *C. sativa*, called Gold of Pleasure, is cultivated chiefly for the oil obtained from its seeds. They are dwarf annual or perennial plants, with stem-clasping leaves and terminal racemes of small yellow flowers. The oil obtained from *C. sativa* is of a clear yellow colour, and the residual cake has been recommended for cattle, but is too acrid. The stems contain a considerable proportion of fibre, and in some parts of the Continent are used for making brooms.

Camellia (so named in honour of Kamel, a Spanish Jesuit). A beautiful genus of evergreen shrubs inhabiting China and Japan. Several species are known, one of which, *C. oleifera*, furnishes the Chinese with abundance of oil used for various domestic purposes. Others are small-flowered and unimportant; but one, *C. japonica*, is among the most beautiful plants of the vegetable kingdom. It is from this that the multitudes of double varieties, now common ornaments of greenhouses in the spring, have been obtained partly by seeds and partly by the perpetuation of sported branches. Most of the varieties originated with the Chinese and Japanese; but many very fine ones have been raised in this country

and Belgium. They are usually cultivated in pots, but are never seen in perfection unless planted in the open ground beneath a glass roof: and under such circumstances they only require to be guarded from severe frost. In some parts of England, and even near London, they are occasionally grown in the open air, but with little success.

Camelopard. [GIRAFFE.]

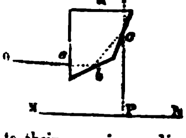
Camelopardalis. One of the constellations formed by Hevelius in the northern hemisphere. It is situated between Cepheus, Cassiopeia, Perseus, Ursa Major, Ursa Minor, and Draco.

Camenæ (Lat.). Divinities, worshipped at Rome, whose name, as shown by the forms Carmentis and Carmenæ, was connected with *carmen* or song. The name was also applied in Roman literature to the nine Muses.

Cameo or **Camaieu.** A word of doubtful origin, applied to gems of various colours sculptured in relief. The art of engraving on gems boasts of high antiquity, having been practised with various degrees of success by the Egyptians, Greeks, and Romans. It was revived in Italy in the fifteenth century, and is even at the present day cultivated with considerable success. The cameos of the ancients were usually confined to the agate, onyx, and sard, which, on account of the variety of their strata, were better suited to display the artist's talents; but they are also occasionally found executed on opal, beryl, or emerald, and even on a sort of factitious stone, the *Vitrum obsidianum* of Pliny, distinguished by the moderns as the antique paste. (*Encyclopædia Metropolitana.*) One of the most famous cameos is the onyx at present in Paris called the *apotheosis of Augustus.* It is one foot in height and ten inches in width.

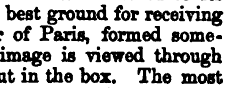
Camera Lucida (Lat.). The name given by Dr. Hooke to an instrument contrived by him for making the image of any object appear on a wall in a light room either by day or by night. It is described in the *Phil. Trans.* vol. xxxviii. p. 741.

The instrument now known by the name of Camera Lucida is a very ingenious invention of the late Dr. Wollaston, for the purpose of enabling anyone, without a knowledge of the rules of drawing or perspective, to delineate distant objects, or trace the outlines of landscapes &c. with perfect accuracy. It consists of a quadrangular glass prism, *a, b, c, d,* by means of which rays of light are bent, by two reflections, into a path at right angles to their previous direction. A ray of light proceeding from O enters the face of the prism at *a*, and continues its course in a straight line till it meets the adjacent side of the prism at *b*, and making with it a very acute angle, is wholly reflected in the direction *b c*. At *c* it again meets the side of the prism, and is in like manner reflected in the direction *c* E. The eye being placed at E, sees the image of the object on the surface of the prism at *c*, and refers it to P, on a plane M N, which may be covered with a sheet of white paper. The point of a pencil can also be seen on the paper, and thus the accurate outline of the object may be traced. It is easy to see from this the proper form which the crystal should have. By the laws of optics, the size of the picture will bear the same relation to the object delineated, that the distance of the eye from the paper bears to the distance of the object. Hence, in order to increase or diminish the size of the picture, the prism is mounted in a brass frame, supported by brass tubes capable of being lengthened or shortened at pleasure. A thin brass plate, affixed to the upper surface of the prism, and having a small hole in it for the observer to look through, keeps the eye in its proper place, and procures steadiness of vision. A convex lens may be placed over the hole in the brass plate, for the purpose of magnifying the image; or a concave lens placed before the prism at *a* will adapt it to short-sighted persons. The instrument is extremely convenient, on account of its portability.



Camera Obscura (Lat.) or **Dark Chamber.** Is an optical apparatus, by which the images of external objects are thrown on a white surface, and represented in a vivid manner in their proper colours, shapes, &c. Hence the apparatus may be used for the purposes of delineation, as well as the camera lucida; but as it is from its construction less convenient, it is chiefly used for the production of images or pictures upon surfaces sensitive to light in the art of photography, and cameras of great optical perfection are now constructed for this purpose.

The common camera obscura is thus constructed: Through a convex lens, or small circular hole at C, the light is admitted into a darkened room or box, so that rays proceeding from an object AB, and falling on a white ground within the room, paint an image of the object in it in an inverted position, *a b*. Sometimes a mirror D is placed in the interior of the box, making an angle of 45° with its sides, whereby the image is thrown down on the bottom of the box at *a b*, and by means of the reflection restored to its natural position. The best ground for receiving the image is plaster of Paris, formed somewhat concave. The image is viewed through an oblong aperture cut in the box. The most perfect camera obscura is formed by placing an inclined mirror in a revolving frame at the top of a building, by which the rays are thrown down on a convex lens in the roof, and the images of all the surrounding objects received on a table. The images being accompanied by the motions belonging to the objects, a very pleasing picture is formed. The invention of the camera obscura is usually ascribed to



Baptista Porta: it was, however, known to Friar Bacon, in the thirteenth century.

Cameralistics. The science of public finance is sometimes so called, in reference to the system adopted by most of the petty princes of Germany, who appoint certain officers, called Kammer-räthe, to superintend their accounts.

Camerated (Lat. camera). A term applied to the shells of certain Cephalopods which are divided by transverse partitions into a series of chambers which are traversed by a siphon. Most of the species are now extinct.

Camerlingo (same as Chamberlain). A title given to one of the cardinals who administers the principal affairs of civil government at Rome.

Cameronians. The strictest sect of Scotch Presbyterians, so called from Richard Cameron, one of the most eminent among their leaders. On his restoration in 1660, Charles II. had sworn to maintain presbytery as the existing national church in Scotland; but the idea that it was incompatible with monarchical government led him, as soon as he could, to establish episcopacy in its place. The presbyterian clergy, driven from their parishes, continued to hold meetings or *conventicles*, as they were called in contempt; and their influence increased in proportion to the stringency of the persecution employed against them. Seeing the uselessness of violent measures, Charles in 1669 granted an *indulgence* or permission to such ejected ministers as had 'lived peaceably and orderly' (i. e. had not held conventicles) to return to their parishes, if these were vacant, or to accept other preferment. A similar indulgence was issued in 1672; but the conditions which accompanied them were not agreeable to tender consciences. (Wodrow's *Church History*, 8vo. ed. vol. ii. pp. 130, 131.) The indulgence, as emanating from the king, without the sanction of the church, was held to imply in the recognition of the royal authority a principle subversive of the national covenants (*Acts of Assembly*, apud an. 1649) and of presbytery, which acknowledged no head but Jesus Christ. While the more moderate accepted it without protest, others satisfied their conscience by giving open testimony against the usurpation of authority, while others refused compliance on any terms; and these last received subsequently the name of Cameronians. (Wodrow iii. 202.) These men at once incurred the disapprobation of their indulged brothers, as well as the anger of the government. Driven mad by oppression, they became fanatical in their views, vilified those who had accepted the indulgence, stigmatised the king and government as unscriptural and Erastian, and ended by throwing off their allegiance to the king, who, they declared, had, by his breach of the covenant and other iniquities, forfeited all right and title to the crown. (Laing's *History of Scotland*, vol. iv. p. 3.) This declaration was affixed by Cameron with about twenty others, all armed, on the market-cross of Sanquhar. (Wodrow iii. 312.) They were soon afterwards (July 20, 1680) surprised at Airmoss, on the confines of Ayr and Dumfries. Cameron and his brother were killed; sixteen, who were taken prisoners, were afterwards hanged; the rest escaped. The party was now led by Cargill (shortly after, taken and executed), who at a meeting of Cameronians at Torwood, near Stirling, excommunicated their persecutors, including the king and the duke of York. (*Hind Let Loose*, passim, Laing iv. 112, 113.) Meanwhile, the Cameronians began to act more in concert, and in 1681 took the name of *The Societies united in Correspondence*. They were now altogether separated from the indulged ministers and the general public; their meetings were confined to mountains, or to remote and secret spots. But while they continued to be the objects of an unremitting persecution, they began to disagree among themselves. Some were displeased with the *Sanquhar Declaration*; others were offended with the violence of Renwick, now at the head of their party, who in 1687 drew up the *Informatory Vindication*. The breach was never healed. Renwick was beheaded in 1688; but the revolution put an end to the sufferings of the Cameronians and to persecution for conscience' sake (*Scotch Worthies*, § Renwick, Hackston of Rathillet, &c.; *Hind Let Loose*.) At this crisis they espoused with enthusiasm the cause of the prince of Orange. A regiment of 800 Cameronians was speedily raised, and behaved with the greatest heroism at Dunkeld and other places. A regiment bearing the name still exists. (Laing iv. 194, 208, 232.) But as, when persecuted, they had never formed a very numerous sect, so now they sank gradually into obscurity. In 1743, under the Rev. J. M'Millan and other leaders, they took the name of the Reformed Presbytery, and assumed the title of the Reformed Presbyterian Synod; but even so late as 1841 the synod consisted only of six presbyteries and thirty-five congregations, most of them being very small. This result may be explained by the nature of their tenets, which denied the authority of civil rulers unless they had subscribed the national covenants, and declared that the civil magistrate is bound to suppress error and encourage true religion. These opinions have been gradually modified or abandoned; and they would have no hesitation to unite with the Establishment if patronage were abolished, and the right of electing ministers vested in the people. [MACMILLANITES.]

Camisards. In French History, the Protestant insurgents in the Cevennes, after the revocation of the edict of Nantes, were so called, from having worn their shirts over their dress by way of disguise on the occasion of some nocturnal attacks. Their principal leader, Cavalier, succeeded so far as to effect a capitulation in their favour with the French government. He subsequently entered the English service, and at his death was governor of Jersey.

Camlet. A stuff or cloth, consisting of a mixture of wool and silk, or of wool and camel's hair.

Camœnæ. [CAMENÆ.]

Camp (Lat. campus, *a field* or *plain*). In the art Military, signifies the station of an army, with its artillery, baggage, and other appendages, when it has taken the field for the purposes of war. The history of camps involves that of the military art in all ages and in all countries. The Lacedæmonians appear among the first people who directed their attention to this subject. Their camps, whenever it was practicable, were of a circular form, which was said to possess the advantage that from the centre, where the general with the flower of the troops lay, help could soonest be afforded to any point menaced by the enemy. The other states of Greece, Macedonia, and Carthage adopted the same leading principle, but accommodated the form and disposition of their camps to the nature and strength of the ground which they intended to occupy. It was from the Romans that the art of castrametation first acquired any systematic regularity. The form of the Roman camp was invariably quadrangular; it was surrounded by regular entrenchments, and was so admirably arranged that each cohort, legion, and individual knew exactly the point which he ought to occupy, and the part to which instant attention should be directed in the event of alarm. The reader will find ample details and comments upon this subject in the works of Polybius and Vegetius, and in General Roy's *Military Antiquities of the Romans in Britain*. The *Penny Cyclopædia* contains an able account of the different systems of castrametation.

In ordinary language, the term is applied to any place where troops are sheltered either by tents or temporary huts, and not by permanent buildings.

Camp-sheeting. A piled enclosure, frequently erected at the foot of an embankment or a cutting in a soft or compressible formation. A camp-sheeting consists of, 1, a guide pile; 2, a whale, or a horizontal piece of timber; and, 3, a series of planks driven in, so as to enclose the space required for the foundation, usually of the thickness of three inches, though this thickness is by no means necessary. A camp-sheeting is, in fact, nothing more than an enclosure by means of a series of planks driven flatwise to the direction of the thrust, and the thickness of the planks is that of the goods most commonly obtained in the market; its object being to resist the outward thrust of the earthwork, on which it is proposed to build, under the influence of a direct load.

Campaign (Fr. campagne). An uninterrupted series of military operations in the field. [WAR.]

Campanile (Ital.). In Architecture, this term is properly speaking applied to a bell tower, whether it be attached to a civic or ecclesiastical building. Though the word has been adopted in the English language from the Italian, and applied to the bell towers of churches especially, it more correctly belongs to those towers near churches, but detached from them, which may be seen in many of the cities of Italy. The principal of these are the campanile of Cremona, which is of the extraordinary height of 396 feet; that of Florence, 268 feet high, built from the designs of Giotto; the Garisendi tower at Bologna, built in 1110, and is 8 feet 8 inches out of the upright; and very near it in the same city, another tower bearing the name of Asinelli, and leaning from the perpendicular 3 feet 3 inches, but which, seen, as it always is, in company with the first, seems to lean but little. The last we shall name will be the Leaning Tower of Pisa, and it is perhaps the most remarkable of them all. It is 151 feet in height, and overhangs 12 feet 9 inches. Its general form possesses elegance, and is that of a cylinder encircled by 8 tiers of columns over each other, and each tier has an entablature. The columns and capitals are all of marble, and the upper tier is recessed back. This characteristic detail of Italian architecture has been repeated of late very successfully at Streatham and at Wilton.

Campanula (dim. of Lat. campana, *a bell*). A very large genus of hardy herbaceous plants and annuals, inhabiting the temperate parts of both the eastern and western hemispheres, but most abundant in the latter. They form the principal genus of *Campanulaceæ*, and have blue or white flowers, often of considerable size, on which account most of the species are favourites in gardens. The only useful plant among them is *C. Rapunculus*, the radish-like root of which is sometimes eaten under the name of Rampion. *C. rotundifolia* is the Hair-bell or Blue-bell of Scotland.

Campanulaceæ (*Campanula*, the typal genus). A natural order of epigynous Exogens, having a valvate regular monopetalous corolla, an ovary with two or more cells, free or half-united anthers, and a naked stigma, which features distinguish it from the rest of the Campanal alliance of which it is the type. The order is an extensive one, chiefly occurring in the north of Asia, Europe, and North America.

Campeachy Wood. Logwood, the produce of *Hæmatoxylon Campechianum*, brought from Campeachy, in the bay of Honduras.

Camphene or **Camphogen.** A term applied by chemists to a hydrocarbon, composed of 10 atoms of carbon = 60, and 8 of hydrogen = 8; it is therefore represented by the equivalent number 68. It is identical with pure *oil of turpentine*; and camphor is its protoxide, that substance being composed of 68 camphogen + 8 oxygen; camphor is therefore represented by the equivalent number 76.

Camphor. A concrete volatile and highly odorous substance, obtained by distillation from *Camphora officinarum*, the Camphor Laurel, which is a native of China and Japan. A species of camphor is also found ready formed in the wood of the *Dryobalanops Camphora*, a tree which flourishes in Borneo and Sumatra. What is called *crude* or *rough* camphor is in

small grey pieces and crystals; it is purified by sublimation, and is found in commerce in circular cakes weighing about eight pounds each, white, translucent, and somewhat tough and crystalline in texture. Camphor is chiefly used in medicine: it dissolves very sparingly in water, and the solution is called *camphor julep*; it dissolves abundantly in alcohol, forming *camphorated spirit of wine.* The word is connected by Dr. Ure (*Dict. of Arts, Manufactures, and Mines*) with the Arabian name *Kamphur* or *Kaphur.*

Camphor, Artificial. A substance much resembling camphor, obtained by the action of hydrochloric acid on oil of turpentine.

Camphor Oil. A liquid which exudes when the bark of the Borneo camphor-tree is incised. It is a solution of camphor in a hydrocarbon termed borneene.

Camphora. A genus of *Lauraceæ*, differing from *Laurus* in its ribbed leaves, its fewer (nine instead of twelve) fertile stamens, and its four-celled anthers. One of the kinds of Camphor met with in commerce is the produce of *Camphora officinarum*, which also bears the name of *Laurus Camphora*, and *Cinnamomum Camphora.*

Camphoric Acid. An acid obtained by boiling camphor in nitric acid. It consists of 60 carbon, 8 hydrogen, and 5 oxygen; or of 1 atom of camphor and 4 atoms of oxygen.

Camphrone. A volatile liquid obtained on passing camphor vapour over red-hot lime.

Campylotropal (Gr. κάμπυλος, *curved*, and τρέπω, *I turn*). In Botany, a term applied to such ovules as bend down upon themselves till their apex touches the base. They are extremely common in plants, and are more particularly those in which a raphe exists; the latter being a bundle of vessels whose office is to maintain a communication between the base of the nucleus and the base of the seed.

Canal (canalis, from canna, Gr. κάννα, *a hollow reed*: whence also *gun*). An artificial channel filled with water, formed for the purposes of draining, of irrigating, of supplying towns with water, or of inland navigation. The canal by which the Lago Fucino drains into the river Liri, may be cited as an illustration of the first use; of the second, the canals with which ancient Egypt was intersected; of the third, the artificial aqueducts of antiquity, or, in modern times, the New River, by which London is in a great measure supplied by the streams from the head of the Lea, and the Canal de l'Ourc, by which Paris is supplied from the valley of the Marne; but the term is usually applied to channels made for the purpose of inland navigation.

That the importance of canals as a means of inland navigation attracted attention even in the earliest ages, is manifest from the Fossæ Philistinæ, large canals (Pliny iii. 16) at the mouth of the Eridanus in Liguria, as well as from the grand design of the Cnidians, a people of Caria in Asia Minor, to dig a channel through the isthmus which joined their territory to the continent. (Herod. ii. 78.) The attempt of the Egyptians, both under the Pharaohs and the Ptolemies, to unite the Nile with the Red Sea by means of a navigable canal has been often mentioned, though at the present day it is difficult to discover the least traces of its existence. The Greeks conceived the idea of making a navigable passage from the Ionian Sea into the Archipelago, by cutting across the isthmus of Corinth. This undertaking, however, proved abortive; and though the attempt was again renewed by several of the Roman emperors, it still remained without success. In the reign of Augustus, Drusus succeeded in excavating a canal from the Rhine to the Yssel, and formed, as we are told by Pliny, a new mouth from the Rhine to the Sea. A canal between the Rhine and the Maese, supposed to be that now commencing at Leyden, and passing Delft to its junction with the Maese at Sluys, was likewise formed by the Romans. But, as has often been observed, it was by bending nations under the same yoke, and not by uniting them by commercial ties, that the Romans sought to extend international communications; hence their canals were either formed for the purpose of warfare, or of draining. There can be little doubt, however, that it was the Romans who introduced, into their provinces, the models of internal communication, which in modern times have undergone such immense improvement, and which have been converted to a nobler purpose than conquest—the interchange of labour.

There is no country in the world where the advantages of canals are more appreciated than they are in China. From time immemorial the rivers that intersect that vast empire have been united by innumerable canals; and the Grand Canal is said to be the most stupendous work of the kind that has ever yet been executed. Russia, too, exhibits a remarkable degree of enterprise in the construction of canals for the purpose of inland navigation; and though innumerable difficulties peculiar to that country for a long period impeded the progress of works of this kind, that empire is now traversed by an unbroken line of water communication from St. Petersburg to the Caspian Sea.

The canals constructed during the period of the glory of Italy are very numerous, and it is said that the invention of locks originated in that country; but though many of the canals there made were navigable, their primary object seemed to have been to communicate to both banks of the Po the various productions of the country drained by its affluents.

In the Netherlands, the construction of canals commenced in the twelfth century, when Flanders became the commercial entrepôt of Europe; and to the large share which canals possess in its economical arrangements is to be ascribed chiefly the prosperity of Holland at the present day. From the structure of that country, canals are formed in it with peculiar facility; and there is not a town, or village,

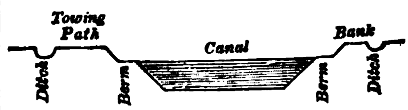
which is not furnished with a canal of greater or smaller dimensions. France has from a distant period exercised the skill of her engineers in the construction of canals for inland navigation. The first was the canal of Briare, which opens a communication between the Loire and the Seine, and thence between Paris and the western provinces, and is of immense importance in inland commerce. Omitting many works of this kind, completed, in progress, or contemplated in that country, the canal of Languedoc may be mentioned as being the first canal executed to connect two seas. It was intended to join the Mediterranean with the Atlantic, and was considered, at the time of its execution, a stupendous undertaking. It is 150 miles long, is supplied by a number of rivulets, and is provided at proper intervals with 114 locks and sluices.

A reference to the early history of Spain, Sweden, and Denmark, and to the more recent histories of Austria, Russia, and above all to that of the late United States of America, will show to what an extent those several states have endeavoured to develope their internal resources, and to distribute universally the productions of labour by means of canals of internal navigation.

It is a singular circumstance that Great Britain, generally foremost in the race of civilisation, and possessing so many natural means for the formation of canals, from its insular position and its numerous rivers, should have been the last nation in Europe to avail itself of those advantages. It is true that at different periods of our history the importance of internal navigation was deeply felt, and various expedients were adopted for removing obstructions in the rivers of England, with a view of facilitating commerce; but it was not till the middle of the last century that the construction of canals began to enter in the system of British economy. In the year 1755 an impulse was given to the construction of canals in England by the project, which was originated by the duke of Bridgewater, of forming a canal from Worsley to Manchester; a project which was altered, and extended, by three successive Acts of Parliament, to admit of greater comprehensiveness in its execution, and has formed the basis of all future plans of canalisation in this country. The example then set by the duke of Bridgewater was soon followed; the large amount of capital in England, which is ever ready to be risked in undertakings that are likely to prove advantageous, soon found its way into this class of investments, and in a short time the country became intersected with navigable canals.

The section of a canal is usually a trapezium of which two sides are parallel, and horizontal, and the other two equally inclined to the horizon, but in different directions. The inclination depends on the nature of the soil traversed. It is least in tenacious earth, and greatest in loose soil; but no soil will permanently maintain itself unless the base of the slope be to the height in the ratio of 4 to 3; in loose soils the ratio of the base to the height may require to be 2 to 1, or even in some cases 4 to 1.

A canal is usually confined between a bank on one side and a towing path on the other, the breadth of whose upper surface must be sufficient for a road, on which the animals employed in draught may easily pass. This requires the breadth of the upper surface to be at least nine feet. The usual rule for the other bank is to make the breadth at the top equal to the height measured from the top of the canal; but in this case there should be a berm at the foot of the bank, of a foot, or a foot and a half, at the level of the top of the said canal, which tends to diminish the danger of the wash of water upon the bank. To prevent the entrance of rain-water, a counter ditch is formed on the outside of each of the banks. The profile of a well-constructed canal will therefore present the following figure:—



The dimensions of navigable canals must depend upon the size of the vessels designed to navigate them. In order that they may admit two vessels to pass one another with freedom, the breadth at bottom is made twice as great as the beam of the vessels; the depth that is required is at least one foot more than the draught of the vessels. It results from this fact that there is a great latitude in the dimensions of the canals; and the widths observed by the French government in the works of this kind, executed in that country since 1822, are the most generally approved. They are for canals of *grande navigation* 49 feet 6 inches upon the water line, and 33 feet 4 inches upon the bottom line, with a depth of about 5 feet 6 inches; the canals of *petite navigation* are only 33 feet 4 inches on the water line, and 22 feet on the bottom, with a depth of five feet; canals for steam navigation are made wider than the above.

The bed of a canal is made absolutely level, or it must have only such a slope as is required to convey water to replace that which has been wasted. Hence when a canal intersects a sloping country, in a series of channels at different levels, means must be provided to enable vessels to pass from one level to the other. This is commonly effected by means of locks; but in cases where the difference of level is very great, the trouble and expense of such an operation as passing a chain of locks is obviated by a system of passing the boats from one level to the other by the aid of steam or other machinery.

The invention of locks, as a means of carrying a canal through an undulating country, has given an entirely different character to the inland navigation of Europe from that which it had before. Various nations have claimed the

honour of this invention; and though Italy appears the most entitled to it, the controversy which has been raised on the subject has not yet been settled. A lock is a chamber formed of masonry, occupying the whole bed of the canal, where the difference of level is to be overcome. This chamber is so contrived that the level of the water may be made to coincide with either the upper, or the lower, level of the canal. This is effected by two pairs of gates, one of which is placed at each end of the chamber of the lock. By this means, while the gates at the lower end of the chamber are opened, and those at the upper end are closed, the water in the chamber will stand at the level of the water in the lower part of the canal; and, on the contrary, when the lower gates are closed and the upper gates are opened, the level of the water in the lock will coincide with the level of the water in the upper part of the canal. In the first case a boat may be floated into the lock from the lower part of the canal; and if then the gates be closed, and water be admitted into the lock from the upper level until the surface of the lock is in a line with the water above, the boat will be floated up, and on the opening of the upper gates may be passed onwards. By reversing this course of proceeding, boats may readily be conveyed from the upper to the lower level. [LOCK.]

The supply of water required for the maintenance of the navigation on a canal depends 1st, on the *lockage*, or the quantity which is used in passing the vessels through the locks; 2nd, on the evaporation from the exposed surface; and 3rd, on the leakage. The loss of water from imperfections in the locks, and from any sudden affluence of boats in a reach of the canal, must also be taken into account. The quantity of the lockage may be estimated from the traffic return, but that required to compensate for the evaporation must necessarily differ according to the circumstances of the locality traversed by the canal. The usual calculation is that the quantity required for this purpose must be equal to $\frac{1}{16}$ or $\frac{1}{12}$ of an inch over the whole surface of the canal; and experience has shown that it is not too much. With respect to the leakage, it must depend upon the materials of which the banks are made, upon the area exposed to this action, and to the degree of saturation of their materials; but in ordinary cases it may be assumed that an allowance of two inches, upon the water surface, will be sufficient to compensate for this cause of loss. The loss consequent upon the imperfections of the locks and works must depend upon the care with which those works are maintained; it seems, however, to be admitted that, after a few years' service, a lock gate will allow 10,000 feet cube to escape in twenty-four hours, and that it is necessary to provide for that quantity. The affluence of boats in a particular reach of the canal must be appreciated by local knowledge, for there can be no law regulating it. It may be observed that, in order to diminish the loss by infiltration, the banks of a canal are *puddled*, or lined with a material impermeable to water. In England clay is used for this purpose; in France, on the contrary, a layer of concrete is substituted with very good results.

The advantages derived from canals are now so generally known, and acknowledged, as to render it almost superfluous to refer to the question, were it not that of late years the competition of railways has proved extremely injurious to them. In fact, the rapidity and the certitude with which the ordinary class of goods can be delivered by the latter mode of conveyance has rendered it a decided favourite in public estimation; but for heavy, cumbrous articles, the economy of water transit must always insure the preference for canals. There may be a question as to the advisability of establishing canals at the present day in new places; and, though the French government persists in making them, there seems to be every reason to believe that in so doing it is but wasting capital in unproductive works. Still, when once established, canals are able materially to advance the public interests, and to keep down the price of many kinds of goods carried over them. The only conditions of effecting this object are economy and simplicity in the system of traction, and a good mode of management so as to avoid all unnecessary delays and loss. For this purpose steam has lately been employed on the Regent's Canal, and in the river navigation of France, with considerable success; and the canal companies have in some cases taken upon themselves to do all the traction as it is performed on railways, instead of leaving it to the separate wharfingers. If these improvements be steadily persevered in, there can be no doubt of the success of the system, and canals will again become, as they long were, a source of wealth and prosperity to the country where they have been executed.

For further information on the subject of canals, the reader is referred to Philips's *General History of Inland Navigation*; to Nichols, Priestley, and Walker's *Historical Account of the Navigable Rivers, Canals &c. of Great Britain*; to Sganzin's *Cours de Construction*; Minard's *Cours d'Architecture*, &c. &c.

Canaliculate (Lat. canalis, *a water-pipe*). In Botany, applied to leaves or other parts when the edges are so much turned upwards, or the surface is so much hollowed out, as to produce the appearance of a channel or gutter.

Canalifera (Lat. canalis, *a canal*; fero, *I bear*). The term *Muricidæ* is now applied to the family. The name of a tribe of Zoophagous Univalves, or Gastropods, of which the shell is characterised by a long straight canal terminating the mouth.

Canarium (Canari, its Malay name). The name of certain tropical Indian trees, of the order *Amyridaceæ*, bearing compound leaves and diœcious panicled flowers. *C. commune* is cultivated in the Moluccas and Java for the sake of its fruits, which also yield an oil used

at table and for burning in lamps. The exudation from its bark resembles balsam of copaiba in its properties. *C. strictum* is known in Malabar as the Black Dammar-tree.

Canary-bird. Two distinct species of finch (*Carduelis*) appear to have afforded the different varieties of singing-bird familiarly known by this name. The one which is best known in its wild state is the *Carduelis canaria* of Cuvier, and is very abundant in Madeira, where its characters and habits have been observed with much attention by Dr. Heineken. The canary-bird was brought into Europe as early as the sixteenth century, and is supposed to have spread from the coast of Italy, where a vessel, which was bringing to Leghorn a number of these birds besides its merchandise, was wrecked. As, however, they were males chiefly which were thus introduced, they were for some time scarce; and it is only of late years that their education and the proper mode of treating them have been known.

Canaster. The rush basket in which tobacco is packed in Spanish America; whence *canaster tobacco*.

Cancel (Fr. canceller). In Printing, a leaf to be cut away by the bookbinder and another reprinted leaf substituted, or part of a sheet, usually indicated by a *, †, ‡, &c., in the signature.

Cancellaria. A Lamarckian genus of Trachelipod Testacea, having the shell oval or turreted; base of the aperture sub-canaliculate; canal very short; columella plicate; the plaits usually transverse, varying in number; lip internally furrowed; operculum horny. The reticulated Cancellaria (*Cancellaria reticulata*, Lam.) is a well-known species, from the Atlantic Ocean.

Cancellate (Lat. cancelli, *lattices*). In Botany, a term applied to leaves consisting entirely of veins, without connecting parenchyma, so that the whole leaf looks like a plate of open network. Instances of this kind occur in *Ouvirandra fenestralis*, the lattice-leaf plant, but they are extremely rare.

Cancer (Lat.). The *Crab*. The fourth sign of the Zodiac, which the sun enters about the 21st of June, when he reaches his greatest northern declination. The first point of Cancer is 90° distant from the first point of Aries, and is called the Summer Solstice. The parallel circle through this point is called the *Tropic of Cancer.*

CANCER. A disease chiefly attacking the glands, consisting of a scirrhous tumour, terminating in an ill-conditioned and deep ulcer, generally attended by excruciating pain. When the cancerous character of a tumour is once ascertained, its extirpation, where practicable, is the only chance of effectual relief. The large blue veins which ramify round a cancer of the breast were compared by old authors to the claws of a crab, whence the name of this disease.

CANCER. The Linnæan generic name for the modern Brachyurous family of Crustaceans.

Cancrinite. A silicate of alumina and soda with carbonate of lime; remarkable as an instance of a silicate containing carbonic acid as a constituent element.

It occurs in Norway, the Ural, Transylvania, and at Litchfield, in the state of Maine, in North America, both massive and in crystals. Named after Cancrin, a Russian minister of finance.

Cancroma. A genus of *Grallatores* or wading birds, belonging to Cuvier's family of *Pressirostres*, or compressed-billed waders, including only one known species, the Boatbill; so called from the form and structure of the bill, which characterises the genus. The bill is flattened or depressed, not compressed; and is composed of two boat-shaped or spoon-shaped mandibles, with their concavities applied towards each other, the upper one having a strong and sharp tooth near the point. The Boatbill inhabits the banks of the Orinoco and other large rivers of South America, which are subject to flooding in the rainy season.

Candelabrum. The Latin name for the stand, or support, on which a lamp was placed. Candelabra varied in form, and were highly decorated with the stems and leaves of plants, parts of animals, flowers, and the like. There was no article of furniture in which the ancients displayed more taste and elegance of design than in candelabra. The etymology of the word would seem to assimilate the candelabrum to our candlestick; it is, however, quite certain that the meaning of the word *candela* was nothing more than that of a lamp, and that the *candelabrum* was a support, more or less heavy in construction, upon which the lamp was placed, or whose top was hollowed out for the reception of oil, or some other combustible. The great variety observable in ancient candelabra was not so much dependent on the caprice of the artist as on the uses to which they were first applied. Before the employment of oil, the mode of illuminating an apartment was by means of dry wood burnt on braziers (basins for holding fuel), supported by tripods. The Greeks, always delighting to preserve some reminiscence of an ancient usage, thence adhered to the triangular form in this article of furniture, and their example was followed by the Romans. Generally speaking, there are two species of candelabra: those which ended upwards in the form of a brazier, so nearly approaching the form of a portable altar as to be almost confounded with it; and those which possessed accessories and ornaments of the same character as those before described, but much higher in relief, and of marble. The first species must be classed with the tripod, and there seem to be reasons for believing that it was used only in temples and in small chapels. They were frequently sculptured in friezes, usually accompanied by genii and instruments of sacrifice. The other species seems to have been more common, and Rome furnishes numerous instances of them; but, as Winkelmann observes, not one of this kind has been found in bronze.

The marble candelabra exhibit as much variety in the form of the vase, or brazier, which it is their principal purpose to support, as in the body and base of the support itself. Sometimes they are capricious to excess, the contrivance and design of the foliage being such as to display more skill than propriety of taste. Others, however, there are which are exquisite models of form, taste, ornament, and execution. The Museum of the Vatican contains perhaps the finest collection in Europe of this species. There is one to be seen there of 7 ft. high, resting on griffins, or lion's paws; the general form of its shaft is that of a baluster, which supports a vase-shaped basin; it is highly decorated with foliage and Bacchantes in alto rilievo. Our British Museum presents some specimens; but not of the first class. For full particulars on this subject the reader is referred to Piranesi's work, *Vasi, Candelabra, e altri Monumenti.* Lachausse thinks that the marble candelabra were used in temples more for the purpose of adding splendour to the service than of lighting it; but it seems probable that many with which we are acquainted, such as those that were found in the Baths of Titus, where numbers of apartments did not receive the light of day, actually held artificial light. The most curious specimens of candelabra, as respects form, use, and workmanship, are those found in the excavations of Herculaneum and Pompeii. They are all of bronze; and that they were employed for domestic purposes is proved from the representation on an Etruscan vase of one which serves to give light to the guests assembled round a banquet-table. They are slender in their proportions, and perfectly portable, rarely exceeding five feet in height. It is to be observed that none of the candelabra hitherto found exhibit any appearance of a socket, or of a spike, at the top, from which an inference of the use of candles could be drawn.

Candidati (Lat.). Candidates for public offices at Rome were so called, apparently, because they then appeared in public either with a white toga, or a dress with white marks. Livy (iv. 25) mentions a law, prohibiting anyone from putting white upon his dress, directed against the offence of *ambitus*, or improper solicitation of votes. By another law (Livy xl. 19) persons convicted of this offence might not become candidates again for ten years.

Candite. A kind of Pleonaste (Spinel) in which part of the magnesia is replaced by protoxide of iron. It is found in the rivers and alluvial district near Kandy (whence the name *Candite*) in Ceylon. Specimens of extremely beautiful colours are stated by Sir E. Tennent, in his work on Ceylon, to be met with at Kandy, in the bed of the Mahawelli-ganga (vol. i. p. 36).

Candlemas. A church festival, held on the 2nd of February, to commemorate the purification of the Virgin. The name probably arose from the number of lighted candles used in the processions of the day; or perhaps from a custom of consecrating candles on that day for the rest of the year. This practice was abolished in England in the second year of the reign of Edward VI.

Candles (Lat. candela, from candeo, *I shine*). These are an important article of manufacture, and may be composed of a variety of materials. The principal are: 1. *Wax candles*, which are made by pouring melted wax over the wicks, which, for the convenience of turning and placing them successively over the cauldron, are usually attached to the circumference of a hoop. When of a proper thickness, they are rolled smooth upon a table, and the ends are cut and trimmed. It is in consequence of this method of manufacture, that when we cut a wax candle we see that it is composed of successive layers or coats. Attempts have been made to cast wax candles in moulds, but those which are thus made never burn so well as those which are *poured*. 2. *Spermaceti candles*, or mixtures of wax and spermaceti. This material forms a very good and cleanly candle; but in consequence of its ready fusibility and hardness when concrete, it does not admit of being carried about without spilling the melted material. The fused portions also, which run down the candle, are apt to curl up and fall upon the table. 3. *Composition candles.* This term was originally conferred by a manufacturer who had a large stock of spermaceti candles on hand which were of a dirty hue, and which therefore were unsaleable; he advertised them under the above name, and they were soon disposed of, under the notion of their being composed of some new combination of materials. The term has since been applied to various mixtures; but what are now sold under the name of composition candles are chiefly mixtures of spermaceti, tallow, and a little resin, and occasionally wax. 4. *Tallow candles*, which are either cast upon the wick in pewter moulds, or made by dipping the wicks, attached in rows to proper frames, into melted tallow. 5. *Stearine candles.* Under this term we may include cocoa-nut oil candles, and a few others made of the stearine, or what may be compared to the *spermaceti* of the vegetable oils. The stearine, or rather the *stearic acid* of tallow, is also now extensively employed for making candles.

A candle may be considered as a portable gas apparatus, and its philosophical history involves a number of very curious points, which we can only superficially advert to here. The combustible material, in a state of fusion, is drawn up in successive portions by capillary attraction into the heated part of the wick, the texture, materials and dimensions of which are matters of much importance. If the wick be too large, the candle flares and smokes, producing a peculiar suffocating smell in the room, and often wants snuffing; if, on the contrary, the wick be too small, the candle burns dimly and gutters. In the former case, unburnt carbon soon collects in the upper part of the flame, and if not removed is apt to fall into the cup of the candle, where it forms

a kind of second wick, rapidly melting away the tallow and disfiguring the candle, and occasionally, where candles are inadvertently left burning, falling upon the table and setting fire to any combustible within its reach. This evil may to a great extent be prevented by inclining the candle at an angle of about 45 degrees, so as to keep the upper part of the wick out of the flame. In this way the air has access to it, and the charcoal, which otherwise collects into a head, is burnt as soon as deposited. Where it is required to keep a common tallow candle burning during the night, the necessity for snuffing, and the risk of mischief, may be prevented by so inclining it; and candlesticks have been contrived for the purpose, which, though effective, are very unseemly. With good wax the wick is more easily adjusted to the wants of the flame, and the necessity of snuffing to a great extent prevented; but adulterated wax is often more troublesome than tallow. Great care is also requisite in selecting the cotton for the wicks of candles, which should be of such a nature as to leave no ash, or scarcely any, when burnt. The wick is occasionally impregnated with different substances, and sometimes so plaited as to curl out of the flame, and thus prevent the necessity of snuffing; but the details of these contrivances would be foreign to the object of this work. The following table contains the results of some experiments made by Dr. Ure, with a view of ascertaining the relative intensities of light and the duration of different candles:—

Number in a pound	Duration of a candle	Weight in grains	Consumption per hour in grains	Proportion of light	Economy of light	Candles equal to one Argand
10 Mould	5h. 9m.	682	132	12·25	68·0	5·70
10 Dipped	4 36	672	150	13·00	65·5	5·25
8 Mould	6 31	856	132	10·50	59·5	6·60
6 Ditto	7 2½	1160	163	14·66	66·0	5·00
4 Ditto	9 36	1787	186	20·25	80·9	3·50
Argand oil flame		. .	512	69·40	100·0	

From the above table, it appears from Dr. Ure's experiments that one-eighth of a gallon of good oil, weighing 13 and 1-10th ounce avoirdupois, lasts in a bright Argand lamp 11 hours 44 minutes. The weight of oil it consumes per hour is equal to four times the weight of tallow in candles eight to the pound, and 3 and 1-7th times the weight of tallow in candles six to the pound; but, its light being equal to that of five of the latter candles, it appears from the above table that 2 lbs. weight of oil, value one shilling, in an Argand lamp, are equivalent in illuminating power to 3 lbs. of tallow candles, which cost about three shillings. The larger the flame in the above candles, the greater the economy of light. (Ure's *Dictionary of Chemistry*.) In reference to the comparative cost of coal gas, oil, tallow, and wax, it appears that the cost of a lamp fed by gas, and giving the light of seven candles, will be about one penny per hour; of an Argand lamp fed with spermaceti oil, about threepence; of mould candles, about threepence halfpenny; and of wax candles, about one shilling. Ninety cubic feet of good coal gas, value about sixpence, will produce the light of about ten wax candles for one hour. The recent improvements in the manufacture of stearine and stearic acid have tended to bring about the almost entire disuse of common tallow and even of wax candles. Sperm candles still maintain their ground; but different forms of stearine and stearic acid and their congeners are now the principal bases of all candles in common use; and the general adoption of plaited wicks has led to the disuse of snuffers.

Canellaceæ (Canella, one of the genera). A small natural order of plants, consisting of South American shrubs or trees; one of which, *Canella alba*, is aromatic, and yields the Wild Cinnamon of the West Indies. The bark of this species is imported from the West Indies in quilled pieces of a pale buff colour. It has a biting aromatic flavour, and is sometimes used medicinally against scurvy. From the stamens being united in a column with the anthers sessile on the outside, an affinity has been traced with the *Clusiaceæ*; but on the whole their relationship seems to be near *Bixaceæ* on account of their one-celled ovary with parietal placentæ.

Canephoræ (Gr. *κανηφόροι*, *basket-bearers*). In Architecture, this term is applied to figures of young persons of either sex, bearing on their heads baskets containing the materials of sacrifice. They are frequently confounded with Caryatides, from their resemblance in respect of attitude, and the modern abuse of their application. [CARYATIDES.]

Canes Venatici (Lat.). The *Greyhounds*. One of the constellations formed by Hevelius, in the northern hemisphere. It is represented on the celestial globes and charts by the figures of two dogs, which are also distinguished by the names of *Asterion* and *Chara*.

Canicular Days or **Dog Days.** The name given to certain days of the year, during which the heat is usually the greatest. They are reckoned about 40, and are set down in the almanacks as beginning on the 3rd day of July, and ending on the 11th of August. In the time of the ancient astronomers, the remarkable star Sirius, called also *Canicula*, or the *Dog Star*, rose heliacally, that is, just before the sun, about the beginning of July; and the sultry heat which usually prevails at that season, with all its disagreeable effects, among which the tendency of dogs to become mad is not one of the least disagreeable, were ascribed to the malignant rage of the star. Owing to the precession of the equinoxes, the heliacal rising of Sirius now takes place later in the year, and in a cooler season; so that the *dog days* have not now that relation to the particular position of the *Dog Star* from which they obtained their name.

Canicular Year. The ancient solar year of the Egyptians; so called because its

commencement was determined by the heliacal rising of the Dog Star. The Egyptians chose this star for their observations, either on account of its superior brightness, or because its heliacal rising corresponded with the annual overflow of the Nile. At a very early period of history the Egyptians had perceived that the solar year contains 365¼ days; for their common years consisted of 365 days, and every fourth year of 366, as in the Julian calendar.

Canines (Lat. canis, *a dog*). The pointed, often long teeth, which succeed the incisors; called *dentes canini*, or *laniarii*.

Canis (Lat. canis, *a dog*). The name of a genus of Digitigrade Mammalia, restricted in the modern systems of Zoology to the species of dog, wolf, and jackal; but by Linnæus applied in a wider sense to include the fox and hyæna. With respect to the latter animal, its enormously developed anal scent-glands, its brief coition, and its name, indicate it to belong to the family Viverridæ rather than to that of the dogs, while the prickly tongue and dentition of the hyæna approximate it to the cats. The foxes are generically distinguished from the dogs by the pupils of the eye, which during the day have the form of a vertical fissure, by their less notched upper incisors, and by their longer and more bushy tail. The true characters of the genus *Canis* are six incisors and two canines in each jaw, six molars on each side of the upper jaw, and seven molars on each side of the lower jaw, making in all forty-two teeth, of which there are twenty in the upper and twenty-two in the lower jaw. The first three molars in the upper, and the first four molars in the under jaw, are trenchant and pointing or lacerating teeth; the succeeding molar in the upper jaw is very large, with two sharp cutting points towards the outer edge, and a small tubercle on the inner side interiorly; the others are smaller, and all furnished with tubercles. The first of these tuberculate molars in the upper jaw is very large. In all the wild varieties of the species of canis the muzzle is elongated, and the ears are carried erect; the tongue is unprovided with cuticular spines; the fore feet have five toes, the hind feet four only; both are armed with non-retractile claws; the cæcum is cylindrical, and coiled upon itself; the anal glands are of moderate size; the coitus is prolonged. The dog (*Canis familiaris*, Linn.) is distinguished from the wolf and jackal by his recurved tail; but the varieties, as to size, form, colour, and quality of the hair, are almost infinite. The dog is the most complete, singular, and useful conquest ever made by man over the brute creation: each individual is devoted to his particular master, assumes his manners, knows and defends his property, and remains attached to him till death; and all this neither from constraint nor want, but solely from the purest gratitude and truest friendship. The swiftness, strength, and scent of the dog have rendered him man's powerful ally against all other animals, and have perhaps mainly contributed to the establishment of society. Some naturalists think the dog is a reclaimed wolf, and others that he is a domesticated jackal; nevertheless, those dogs that have become wild again revert neither into the one nor the other species. The wild dogs, and those that belong to savages, as the dingo, resemble, it is true, the wolf in the shape of the head, their straight pricked ears, rough and thick hair, long bushy tail, and lounging gait; moreover, they never bark, but utter a sharp cry or long melancholy howl, like the jackal and wolf; yet they are plainly distinct from both. The Esquimaux dogs present the first traces of a deviation from the wild type; the figure of the legs is more determined, and their pace bolder and more rapid; still they manifest their near relationship to the wolf in their sharp nose, pricked ears, and inability to bark. The Esquimaux and the people of Kamschatka use these dogs as beasts of draught: six or seven dogs will draw a sledge laden with eight or ten hundredweight at the rate of seven or eight miles an hour, and will easily, under these circumstances, perform a journey of fifty or sixty miles a day, when the snow is hard and smooth, and the road level.

The Newfoundland dog may be regarded as the next remove from the Esquimaux variety. These fine and sagacious animals are employed in their native island to draw sledges and carts laden with wood and fish, and to render many other useful services performed elsewhere by the horse. The readiness with which the Newfoundland dog takes the water, his aptitude to fetch and carry, and his powerful and active swimming, have been the means of preserving the lives of many human beings. Another variety of dog nearly allied to the Newfoundland breed, and belonging to the same subdivision (*Avicularius*, Linn., or spaniel tribe), has been trained by the benevolent monks of the convent situated near the top of the mountain of Great St. Bernard, to hunt out and extricate such unfortunate travellers as may have been buried under the snow-drifts or avalanches, while attempting the neighbouring dangerous pass between Switzerland and Savoy.

In our own country, the shepherd's dog offers the example of one of the purest races of the domesticated animal, and that which, in its straight ears, its hair and tail, approaches nearest to the original stock. The shepherd's dog, though outwardly resembling in many points the 'dingo,' possesses a greater cerebral developement, which continues to increase together with intelligence in the spaniel and barbet. Guided by the form of the cranium, we should associate the spaniel and its immediate varieties with the shepherd's dog, the wolf dog, the Newfoundland and Mount St. Bernard dog, and the Esquimaux dogs in one family (*Sagaces*).

A comparison of the crania indicates a closer affinity of the 'dingo' with the family *Pugnaces*, including the mastiff and Danish

dog, than with the *Sagaces*. After the pugnacious mastiff and its varieties, as the bulldog, remarkable for the shortness and strength of its jaws, come the hound, the pointer, and the terrier, in the order of cerebral developement. The varieties of this family (*Venantes*) differ between themselves chiefly in the size and proportions of the limbs; the greyhound is longer and more lank, its frontal sinuses are smaller and its scent weaker.

The bandy-legged turnspits, and the small pet dogs, as the pugs, poodles, Italian greyhounds, King Charles's breed, &c., are the most degenerated productions of the genus, and exhibit the most striking instances of that power to which man subjects all nature.

With some exceptions among this latter anomalous group, all the domestic varieties of the genus *Canis* are easily and naturally referable to one or other of the three great tribes above mentioned, of which the mastiff, the hound, and the spaniel may be regarded as the several types, and which we have named *Pugnaces*, *Venantes*, and *Sagaces*, from their prominent aptitude respectively for the combat, the chase, and those more varied and complicated services which seem to demand for their fulfilment a greater amount of intelligence in our canine auxiliaries.

In all the varieties of the dog, the following circumstances in his economy are constant:—He is born with his eyes closed; he opens them on the tenth or twelfth day; his teeth commence changing in the fourth month; and his full growth is attained at the expiration of the second year. The period of gestation is sixty-three days, and from six to twelve pups are produced at a birth. The dog is old at fifteen years, and seldom lives beyond twenty.

Canis Major (Lat.). The *Greater Dog*. One of the forty-eight constellations of Ptolemy, in the southern hemisphere, and under the feet of Orion. Sirius, the brightest of all the fixed stars, belongs to this constellation.

Canis Minor (Lat.). The *Lesser Dog*. Is also one of Ptolemy's forty-eight constellations. It is in the northern hemisphere, just below Gemini. Its most conspicuous star is Procyon, of the first magnitude.

Canister Shot. [CASE SHOT.]

Canna (Gr. and Lat.). A genus of *Marantaceæ*, the round hard black seeds of which, produced in a tubercular capsule, are called Indian Shot. The flowers have three outer pieces, or sepals; six inner, of which one is reflexed, which are perhaps abortive stamens; one fertile petal-like stamen with an anther on its margin, and a petal-like style, with a linear stigma.

Canna Starch. The fecula of the *Canna coccinea*, sold in the shops under the name of *Tous les mois*. It is imported from St. Kitt's, and is a good substitute for arrowroot. Its granules are comparatively large, and form an excellent microscopic object.

Cannabinaceæ (Cannabis, one of the genera). A natural order of Exogens, included in the Urtical alliance, and distinguished therein by having solitary suspended ovules, and a hooked exalbuminous embryo, with a superior radicle. The Hemp and the Hop are the only members of the order, the former inhabiting the cooler parts of India, and the latter the south-eastern provinces of Europe. They are diœcious plants, with lobed stipulate leaves, and small inconspicuous flowers.

Cannabis (Gr. *hemp*). The typical genus of *Cannabinaceæ*, the only species of which, *C. sativa*, is a tall annual, with elegant palmate leaves, and altogether inconspicuous flowers; those of the female plants are succeeded by the fruits known as hemp seeds. The stem yields the valuable hemp fibre; and a resinous exudation, extending over the whole surface of the plant, is the stimulant intoxicating Haschisch, the properties of which are powerfully developed in the sunny climate of the East. [ASSASSINS.] The dried plant is sold in the Indian bazaars under the name of Bang, and the resin itself under that of Churras. It is used by Asiatics in the same way, and for the same purposes, as opium.

Cannel Coal or **Parrot Coal.** A variety of bituminous coal, which differs from the purer kinds of ordinary coal and jet in containing extraneous earthy matters, which render it specifically heavier than water. It varies much in appearance, but is generally of a brown or black colour, with a dull earthy to a brilliant waxy lustre. It is very dense and compact, and not easily frangible, breaking with an uneven or largely conchoidal fracture, and does not soil the fingers. When burning, it splits and crackles, without melting, and leaves 3 or 4 per cent. of ash. Being hard enough to take a polish, it is sometimes made into ornamental articles like jet; but its principal value is as a gas-coal. The name is a provincial pronunciation of the word *candle*, which has been applied to it in consequence of the bright flame with which it burns, or because the poor people of some places in the colliery districts sometimes use it instead of candles. By the Yorkshire miners it is called Branch Coal. Cannel coal is found in many of the English collieries, especially at Broseley in Shropshire, and at Wigan in Lancashire; also in the Scotch coalfields of Linlithgowshire, and elsewhere. From the way in which it crackles or chatters in the fire, this kind of coal is commonly called Parrot Coal in Scotland.

Cannelures (Fr.). Circular grooves cut in the cylindrical part of a cylindro-conoidal shot.

Cannibals or **Anthropophagi** (Gr. ἀνθρωποφάγος, *eating men*). Persons that devour human flesh. The ancient authors, but especially Herodotus, have recorded instances both of individual and national addiction to this revolting practice. In the middle ages it was customary for parties engaged in hostilities to accuse each other of cannibalism; but such allegations originated more in a desire, natural, perhaps, to sworn enemies in

those rude times, of fixing upon each other the most barbarous practices, than in any actual perpetration of this deed on either side. At the present day cannibalism is practised by some of the Indian tribes of North America, the Battas of Sumatra, and, more systematically, by the inhabitants of the Fiji islands. The word Cannibal is of doubtful origin.

Cannon. This word is derived from the Greek and Latin canna, *a reed*, and is used to denote the tube from which missiles are projected by the force of gunpowder.

There is much difficulty in tracing the earliest history of *cannon* in this sense of the word. It is certain that fiery projectiles were thrown from tubes in warfare long before the propulsive force of gunpowder was known; and when this great power began to be recognised, the engines with which it was employed were often called by the names of other engines employed for other means of propelling missiles. Almost every nation in Europe, and some of those of Asia, claim the discovery of this force, and to have been the first to employ cannon; but this must remain an open question till some adequate contemporary voucher can be produced. The first document of this nature hitherto found is among the Ordinances of Florence, and is dated in the year 1326: it authorises the manufacture of 'canones de metallo.' After this date evidences of the use of cannon are frequent, though no picture of a cannon has yet been found in any MS. of this century. In the first half of the fourteenth century, cannon were very small, and threw arrows and little balls of lead and iron. Their manufacture was improved towards the close of the century, when we find them, under the names of *cannon*, *bombards*, *gonnes*, &c., throwing balls of all weights from one to two hundred pounds.

The earliest cannon were chiefly made of strips of wrought iron arranged longitudinally, and secured by iron hoops shrunk over them. Copper and brass guns were cast very early on the continent of Europe, but not in England till Henry VIII.'s time. In the fifteenth century large cannon were universally employed for siege purposes and the defence of towns. In the work of Valturius, *De Re Militari*, written in the middle of this century, very curious examples of cannon are figured. Towards the close of this century cannon were called after the names of cruel birds and beasts, as basilisk, falcon, dragon, culverin, &c. (Max Müller, *Lectures on Language*, Second Series, p. 229.) To this period belongs the largest cannon existing in Europe, the great bombard of Ghent, sixteen feet four inches long, and with a bore of two feet two inches in diameter. Hitherto cannon had been but little used in the field; now they began to be considered of vital importance everywhere. In the sixteenth century gunpowder was vastly improved by granulation, and cannon had to be made stronger to withstand its force.

Improvements continued to be made from time to time, but it was reserved for the present generation, by the advances made in machinery and metal working, to bring out fully the extraordinary powers of these terrible and destructive engines of war.

For the principles of the construction of cannon, their employment in war, &c., see Artillery; Gun; and Rifled Cannon.

Cannon Bone. In Farriery, signifies the single metacarpal or metatarsal bone of the horse.

Canoe. The American native name for a boat made of a single trunk of a tree hollowed out. Some canoes are made of pieces of bark fastened together; these should be properly called boats. They are of various sizes, and are generally propelled by one, or if large by two or more paddles, like wooden shovels.

Canon (Gr. *κανών*, *a rule*). A word of various significations, of which we can only enumerate the principal.

1. In cathedral and collegiate churches there are canons (*canonici*) who perform some of the services, and are possessed of certain revenues connected with them. These are, strictly speaking, *residentiary* canons: *foreign* canons are those to whom collegiate revenues are assigned without the exaction of any duty.

2. The laws and ordinances of ecclesiastical councils are called canons; whence the phrase Canon Law.

3. The canon of Scripture signifies the authorised and received catalogue of the sacred books. The canon of the Old Testament, as received by the Romish church, differs from that of the Protestant churches in regarding as inspired those books which we reject under the term Apocrypha. The catalogue received by the Jews themselves, which we adopt, was first enlarged by the council of Carthage to the extent in which it is held by the church of Rome, and that decision was formally confirmed by the council of Trent. In the canon of the New Testament, however, the agreement of Christian churches may be considered unanimous. There exists a series of enumerations of the sacred books of the latter covenant in the writings of the first four centuries, the general agreement of which, and the satisfactory reasons which can be assigned in most cases of omission—there are no additions—distinctly mark the universality of the judgment of the early churches in this matter.

4. In Music, a perpetual fugue. The original method of writing this was on one line, with marks thereon, to show where the parts that imitate were to begin and end. This, however, was what the Italians more particularly call *canone chiuso* (shut), or *canone in corpo*.

Canon. In Printing, a large type, seldom used except in posting bills.

Canonesses. A class of religious women in France and Germany. Their convents were termed *colleges*. They did not live in

seclusion. The college of Remiremont was the oldest establishment of this order in France. Similar noble monasteries still exist in Germany, and the revenues and dignities of some belong to Protestants.

Canonical Form. In Mathematics, denotes a form, usually the simplest or most symmetrical, to which, without loss of generality, all functions of the same class can be reduced. A simple illustration will suffice to explain the nature of these forms as applied to quantics; further details will be found in the papers of Messrs. Sylvester, Cayley, Hermite, and others in the *Philosophical*, and *Cambridge*, and *Dublin Magazines*. Every binary quantic of odd degree, for instance the quintic

$$(a, b, c, d, e, f \between x, y)^5,$$

can in general be reduced to the canonical form $u^5_1 + u^5_2 + u^5_3$, where each u is a linear function of x and y. In fact the six disposable constants involved in the u's suffice in general to render the two quintics identical. Mr. Sylvester, in the *Phil. Mag.* 1851, found that u_1, u_2, u_3, are proportional to the three linear factors of the cubic

$$\begin{vmatrix} ax+by, & bx+cy, & cx+dy, \\ bx+cy, & cx+dy, & dx+ey, \\ cx+dy, & dx+ey, & ex+fy, \end{vmatrix}$$

which latter, on that account, has been called the *canonisant*.

Quantics of an even degree above the second, have a different canonical form. That of a quartic for instance is

$$u_1{}^4 + u_2{}^4 + 6\lambda\, u_1{}^2,\ u_2{}^2,$$

where λ is a constant parameter.

The theory of canonical forms is of the highest importance in algebra and geometry; as yet, however, it is in an incomplete state. A good introduction to the subject is given by Dr. Salmon in his *Higher Algebra*.

Canonical Hours. Stated times of the day set apart, more especially by the Romish church, for devotional purposes. In England the canonical hours for the celebration of marriage are from eight to twelve in the forenoon, before or after which that ceremony cannot be legally performed in any parish church.

Canonisant. An auxiliary quantic, upon which depends the resolution of a given quantic to its canonical form. [Canonical Form.]

Canonisation. A ceremony in the Romish church, by which holy men deceased are enrolled in the catalogue or canon of saints. The privilege of canonising was originally common to all bishops, within their respective dioceses: and was first confined to the Pope by Alexander III. in 1170. When it is proposed to canonise any person, a formal process is instituted, by which his merits or demerits are investigated. Hereupon the *beatification* of the person in question is pronounced by the Pope, and his canonisation follows upon the production of testimony to miracles performed at his tomb or by his remains. The day of his death is generally selected to be kept in his honour, and is inserted as such in the calendar. The last canonisations recorded in Ecclesiastical History are those by Gregory XVI. in 1839, when St. Alfonso Liguori, and four others, were so honoured; and the canonisation, by Pius IX. in 1862, of certain ecclesiastics martyred in Japan. [Beatification.]

Canopus or **Canobus** (Gr. Κάνωπος, the name of a place in Egypt). A bright star of the first magnitude in the rudder of Argo, one of the southern constellations. As its declination is about 52½° south, it is not visible in our hemisphere beyond the 40th degree of latitude.

Canopy (Gr. *κωνωπεῖον, a mosquito-curtain*, from *κώνωψ, a gnat*). An ornamental covering over a seat of state, and in its extended signification anything which affords protection from above. In this sense, it is used to express the covering of a niche, or of a statue.

Canoxinite. A silicate of soda and alumina, with carbonate of lime, from the Miasget in the Ural. Three varieties are also found in the granite of Litchfield, in Maine.

Cant. A term used in Architecture to express the sides of a polygon turned from the spectator, or an angular deflection from a straight line which is neither in the same direction to the horizontal, or to the perpendicular, line of the base.

Cant. In Sea phrase, to turn over, or round; a cant is also a piece of wood laid on the deck for the support of a bulkhead.

Cantalite. A yellowish green variety of pitchstone, containing crystals of Glassy Felspar found at Cantal, in France.

Cantata (Ital. from cantare, *to sing*). In Music, a composition for voices, usually of some considerable length and importance.

Cantharides (Gr.). Spanish flies. The *Lytta* or *Cantharis vesicatoria*, or blistering fly. These insects are chiefly brought from Astracan and Sicily: they should be free from mould and dust, of a peculiar but not very strong or nauseous odour, and of a brilliant golden green colour. These flies furnish us with the only ready and certain means of raising an effective blister upon the skin, for which purpose they are reduced to powder, mixed with ointment or lard, and spread thinly upon a piece of leather, which is then applied to the part affected. Their operation is very different in different habits and constitutions: sometimes they produce much local pain and inconvenience, and great general excitement and irritation of the urinary organs; at others they are comparatively quiet in their action; and the blister being applied at bedtime, is found in the morning to have raised the cuticle with a large quantity of serous fluid underneath it, while the patient has scarcely been aware of its agency. The object of applying a blister is generally to transfer internal inflammatory action to the surface; and in deep-seated inflammations, and painful affections of the viscera and larger joints and muscles, they are often astonishingly effective. But blisters should not be incautiously applied: they

sometimes produce troublesome sores, and are followed by erysipelatous inflammation. Care should also be taken to confine them, by a margin of adhesive plaister or other means, to the part upon which they are intended to operate, as they sometimes are displaced, and give rise to awkward accidents. When cantharides are taken internally, they are violently stimulant to the urinary and generative organs.

Cantharidin. The crystalline active principle of cantharides.

Canthus (Lat.; Gr. κάνθος). The corner of the eye, where the upper and under eyelids meet.

Canticle. A name given to certain hymns sung in the ritual of the church; as the Magnificat, the Deus Misereatur, &c.

Cantilever. A piece of wood framed into the front, or side, of a house, and projecting beyond it, to sustain the eaves and moulding of a cornice carried upon it; they are often highly ornamental.

Canto-fermo (Ital. *firm song*). In Music, the subject song, or theme. Every part that is the subject of counterpoint, whether plain or figured, is called by the Italians *canto-fermo.*

Canton. In Geography, the French designation of certain territorial divisions; but applied chiefly at present to the twenty-two districts of which Switzerland is composed, and which, while they form a confederate union like the United States of America, are governed each by a separate judicature and particular laws.

CANTON. In Heraldry, an ordinary formed, either at the dexter or sinister chief of the escutcheon, by two lines meeting at right angles, proceeding from the top or sides of the shield. By the word canton is always understood a canton dexter, unless otherwise expressed.

Canton's Phosphorus. Sulphide of calcium, obtained by heating sulphate of lime with charcoal. It appears to absorb light on exposure and to emit it in the dark.

Cantonite. A variety of sulphide of copper, crystallising, like Galena, in cubes instead of in hexagonal crystals. It is of a bluish black colour, and has a sub-metallic lustre. It is named after Canton Mine, in Georgia, where it occurs.

Cantonment (Fr. cantonnement). When troops are detached, and quartered in different adjacent towns and villages, they are said to be in cantonments. In India the permanent military stations are so termed.

Canvas (Gr. and Lat. cannabis; Ger. hanf, *hemp*; Fr. canevas). An unbleached cloth of hemp or flax, chiefly used to make sails for shipping. Besides serving for various domestic purposes and for the ground of tapestry work, canvas forms the cloth on which painters usually draw their pictures.

Canzone (Ital. from cantare, *to sing*). A kind of lyric poem. Adopted, with some alteration, from the poetry of the Troubadours, it found its way into Italy in the thirteenth century. It is divided, like the Greek strophic ode, into stanzas, in which the number and place of rhymes and metre of verses respectively correspond. The last stanza, commonly shorter than the others (the epodus of the ode), is called *congedo* or *ripressa* (in old French *l'envoy*), and consisted, generally, of a valedictory address to the canzon itself. This form of poetry was adapted by Petrarch to the expression of many different veins of thought—sonorous, elevated, and heroic. The Pindaric ode, somewhat more regular than the canzon, was introduced by Chiabrera. The canzonet was a sort of canzon in short verses, a favourite form with the poets of the fifteenth century.

Canzonet or **Canzonetta** (Ital.; dim. of canzone). In Music, a short song. The Neapolitan canzonet has two strains, each of which is, like the French vaudeville, sung twice over. The Sicilian canzonet is in a kind of jig-time, with six or twelve quavers in the bar. Sometimes both are rondeaus, and repeat the first strain for an ending.

Caoutchouc. This valuable substance is the inspissated juice or sap of several plants. The principal supplies come from South America, and are derived from the *Siphonia elastica* (Hevea Caoutchouc), and probably from other euphorbiaceous plants. It is also furnished by *Ficus elastica* and other moraceous plants; by *Urceola elastica* and other apocynaceous plants; and by *Castilloa elastica* and other artocarpads. It is often termed *gum elastic* and *Indian rubber.* Its general properties and uses are well known. Among its more recent applications are those of elastic wove fabrics, formed of caoutchouc stretched into threads and covered with cotton; and various water-proof clothing, which is made by interposing a layer of caoutchouc between two folds of the cloth, and then forcibly uniting them by pressure. For this purpose the caoutchouc is dissolved by coal-naphtha, and in that state brushed over the surfaces which are to be united.

Caoutchouc is a compound of carbon and hydrogen; when heated it fuses, and afterwards remains viscid; when subjected to destructive distillation at a high temperature, it yields four-fifths of its weight of a highly inflammable and very light volatile oily liquid (hydrocarbon), which has been called *caoutchoucine*, and which is a good solvent of the unaltered caoutchouc. Washed sulphuric ether dissolves caoutchouc, and it is also soluble in several essential oils; but most of the latter solutions leave it in a sticky state on evaporation.

The name is also applied to the juice of *Siphocampylus Caoutchouc*, an elastic gum, very different from the caoutchouc of commerce.

Cap, Percussion. A small cylinder of copper with one end closed, and containing detonating composition. It is placed on the nipple of the musket, and ignited by the blow

of the hammer when the trigger is pulled. The invention of firing small arms by a percussion lock and detonating powder dates from 1807, but the copper cap only came into use about 1842. Fulminating mercury, mixed with spirit-varnish, is the detonating compound principally used in the best gun-caps.

Capacity for Heat. Experiment shows that different quantities of heat are required to raise different bodies to the same temperature, and those substances which require the largest quantity of heat to be raised to a given temperature are said to have the greatest *capacity for heat.* [HEAT.]

Cape (Lat. caput, *a head*). In Geography, the extreme point of a promontory, or of that portion of land which juts out into the sea beyond the general line of the coast; as the Cape of Good Hope, the most southern part of Africa; Cape Horn, the southern extremity of America; &c. On rocky and much indented coasts, capes generally terminate in acute angles, whence they are sometimes denominated *points*; and if the portion of the land which projects is small or not high, the appellation *ness* in England, and in Scotland that of *mull*, is assigned to it, as Sheerness, the Mull of Galloway, &c.

Cape-weed. A dye lichen, called *Roccella tinctoria*, obtained from the Cape de Verds.

Capella (Lat. *a young goat*). A star of the first magnitude, or rather a double star, in the body of the goat carried by Auriga. This star, which never sets in our latitude, is also called a Aurigæ.

Capers. The flower buds of *Capparis spinosa* and of some allied species, in common use as a pickle.

Capias ad Respondendum (Lat.). In Law, formerly a writ for the commencement of personal actions to arrest a party at large or already in custody of a sheriff.

Capias ad Satisfaciendum (Lat.; shortly called *ca. sa.*). In Law, a judicial writ of execution which issues out on the record of a judgment, where there is a recovery in the courts of Westminster, of debt, damages, &c. By this writ the sheriff is commanded to take the body of the defendant in execution. This is the highest execution which can be had against a defendant, and no other can be afterwards had against his lands or goods, unless he die in custody.

Capibara. The largest known Rodent quadruped. It is of aquatic habits, and frequents the rivers of South America. It is the type of the genus *Hydrochœrus*, signifying 'water-hog,' by which name it is sometimes known.

Capillaire. Simple syrup flavoured with orange flowers, or orange-flower water, generally goes under this name, which is derived from the mucilaginous syrup directed in old Pharmacopœias to be made of the *Adiantum Capillus Veneris.*

Capillamentum (Lat. *a head of hair*). An old name of the filament of a flower. [FILAMENT.]

Capillary (Lat. capillus, *hair*). A term applied in Botany to bodies which are long and slender, like a hair.

Capillary Action. When a very narrow glass tube, open at both ends, is inserted in a vessel containing water, the water immediately rises in the tube, and remains suspended at some height above its level in the vessel. If the same tube is plunged into mercury, the mercury in the tube stands at a lower level than in the vessel. These effects are most conspicuous when the width of the bore of the tube is so small as to resemble a hair whence the cause of the phenomena has been termed *capillary action.*

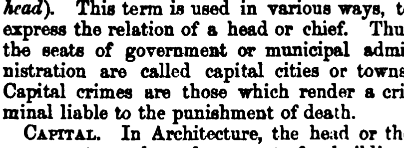
The operation of the same forces which cause the elevation of water and depression of mercury in glass tubes, gives rise to a multitude of other phenomena with which everyone is familiar. If a piece of sugar, or sponge, or blotting paper is brought into contact with water at one extremity, the fluid immediately passes through it and moistens its whole substance. A mass of wetted thread or cloth, hanging over the edge of a basin from the water within it, will empty it as a siphon would. The rise of the oil in the wick of a lamp, of the sap in trees, the functions of the excretory vascular system in plants and animals, depend on the same causes.

Capillary Vessels. In Anatomy, the minutest ramifications of the arteries and other vessels.

Capillitium (Lat. capillus). A kind of purse or net in which the spores of *Trichia* and similar fungi are retained.

Capital (Lat. capitalis, *belonging to the head*). This term is used in various ways, to express the relation of a head or chief. Thus the seats of government or municipal administration are called capital cities or towns. Capital crimes are those which render a criminal liable to the punishment of death.

CAPITAL. In Architecture, the head or the uppermost member of any part of a building; but it is generally applied in a restricted sense to that of a column or pilaster of the several orders, as in the figures here given, in which it will be seen that the Tuscan capital (No. 1)



1 2 3 4 5

consists of an abacus or square shelf on the top, and thereunder an ovolo or quarter round, and under that a neck terminated by an astragal or fillet, which latter is always considered as part of the column itself. The Roman Doric capital (No. 2) here given has an abacus, ovolo, and neck, like the last, and also in addition three amulets under the ovolo and a cyma or ogee, with its fillet above the abacus: the Grecian Doric, however, has only a square abacus and small fillets. The Ionic capital (No. 3)

consists of three leading parts; an abacus composed of an ogee and a fillet; a rind which forms the scrolls or volutes; and an ovolo and astragal at the lower part. The Corinthian and Composite capitals (Nos. 4 and 5) consist of an abacus of a peculiar form, and are decorated with leaves.

The capitals of mediæval art are quite as characteristic of the styles which then prevailed as the classical examples; and the capitals of the tenth, eleventh, twelfth, thirteenth, and fourteenth centuries may be as correctly described as those of ancient art. They usually consist of a square abacus, with foliage arranged in a circular form underneath; and often the foliage is made to assume the form of an octagon or a duodecagon immediately under the abacus, which is modified accordingly. There is, however, more of fancy in the treatment of the capitals of the middle ages than in the capitals of the classical orders, as may be seen by a reference to the article upon this subject in the *Glossary of Architecture* by Mr. Parker, or to the publications of the Architectural Publication Society under the title of a *Dictionary of Terms*. It may suffice here to say that the capitals became more ornate in proportion to the developement of art; and that they gradually increased in complication as mediæval architecture approached its apogee.

Capital. In Political Economy, that portion of the produce of labour saved from immediate consumption which is employed to maintain productive labourers or to facilitate production. [Political Economy.] In Commerce, and as applied to individuals, capital is understood to mean the sum of money which a merchant embarks in any undertaking, or which he contributes to the common stock of a partnership.

Capitation (Lat. capitatio). A tax imposed on the population by the head; e.g. on every one, or every male, above a certain age, &c. [Poll Tax.] In France, the ancient capitation is now replaced by personal and other direct contributions.

Capite (Lat.). In Feudal Law, tenure *in capite* (Ang. *in chief*) signifies a direct holding of the king, the ultimate sovereign, without the intervention of any mesne lord. In England, tenants in capite were either by knight-service or socage; which were converted into common socage by the Act 12 Ch. II. c. 24, abolishing feudal tenures.

Capite Censi (Lat.). In Roman Antiquity, the lowest rank of Roman citizens; so called because, as having no taxable property, they were counted simply by *heads*, as were the Proletarii, who received their name merely as adding to the population of the state.

Capitol (Lat. capitolium). By this name is generally known the great temple of Jupiter on the Tarpeian mount at Rome. There were such capitolia in other cities, as at Capua.

Capitulation. In its original sense, a writing drawn up in several *capitula* or heads. In the language of Military Law, the articles of surrender, when a garrison or other force surrenders to an enemy on terms, and not at discretion. In Ecclesiastical History, articles sworn by bishops and other prelates on admission to their dignities were styled Capitulations. So also was the oath, tendered first to Charles V., and then to the emperors of Germany who succeeded him, by the electors, termed the Election Capitulation (wahl-capitulation).

Capitulum (Lat. dim. of caput, *a head*). A close head of sessile flowers, as seen in the *Compositæ* and some other plants.

Capivic Acid. A resin found in balsam of capivi.

Capnomancy (Gr. καπνομαντεία, from καπνός, *smoke*, and μαντεία, *prophecy*). Divination by smoke was practised among the ancients, both by throwing on the fire seeds of poppy and other herbs, and observing the figures which might be fancied in the smoke; and by observing the smoke of sacrifices.

Capnomor. An oily substance of a pungent and rather agreeable odour obtained from the tar of wood.

Capo d'Opera (Ital.; Fr. chef-d'œuvre). A masterpiece. Capi d'Opera: Masterpieces.

Caponnière (Fr.). In permanent Fortification, a passage leading from one work to another, protected on each side by a wall or parapet, generally of earth, sloping to the bottom of the ditch. When a passage is thus protected on one side only, it is called a demi-caponnière.

In Field Fortification, a double stockade covered with planks and earth at the angles of the ditch is called a Caponnière; it serves to give a flank fire in the ditches.

Caporcianite. A hydrated silicate of alumina and lime found crystallised and in radiated laminæ at Monte Caporciano near Florence and several other localities in Tuscany. It has a flesh-red colour, a pearly lustre, and is only transparent in very thin laminæ.

Capparidaceæ (Capparis, one of the genera). A natural order of Exogenous plants, belonging to the Cistal alliance, and having tetramerous flowers, stamens not tetradynamous, exalbuminous seeds, and closed fruit. They consist of annuals, perennials, bushes, and trees, inhabiting the warmer parts of the world. They have all a powerful pungent or even acrid taste, and have been in some cases used as substitutes for the common mustard; in others they have proved severe poisons. In general their flowers are very beautiful, on account not only of their size, but of their long silken stamens, which are often gaily coloured. The common Caper-bush, a native of rocky places in the north of Europe, is a species of the genus *Capparis*, and yields the flower-buds which, pickled in vinegar, are sold in the shops as an agreeable sauce for various dishes.

Capped Quartz. A kind of Quartz crystal which is found in Cornwall, embedded

in compact Quartz. On breaking the investing matrix, the crystals are revealed, and a cast in intaglio of their pyramidal terminations is obtained, which constitutes the 'capping' which has given rise to the name applied to this variety of Quartz. The French mineralogists call this variety *Quartz encapuchonné*.

Caprella. A genus of Crustaceous animals belonging to the order *Læmodipoda*, found commonly on seaweed. Montague, who describes a species of this genus in the seventh volume of the *Linnæan Transactions*, says the female differs in possessing several plates or valves beneath the body, situated between the two pairs of fins, the use of which is to carry and protect its eggs or young; at which time they extend very considerably, and form a kind of pouch distended with ova, fifteen or twenty of which are easily distinguished between the transparent plates. In this part a very strong pulsation is visible. While examining a female under a water-microscope, the author was surprised to observe not less than ten young ones crawl from the abdominal pouch of the parent, all perfectly formed, and moving with considerable agility over the body of the mother, holding fast by their hind claws and erecting their heads and arms. The characters of the genus, or rather family (*Caprellidæ*), are, body of narrow linear form; eyes composite, and placed behind; legs long and slender, and variable in number, the last joint of the second pair being often toothed on the under side.

Capreolus (Lat.). The old botanical name of the tendril of a plant, for which the term *cirrhus* is now preferred.

Capric Acid (Lat. capra, *a goat*). One of the volatile acids of butter obtained by saponifying it with soda, adding excess of sulphuric acid, and distilling: it passes over mixed with butyric acid, and with two other acids, namely, the *caproic* and the *caprylic* acid. Capric acid has a mixed odour of acetic acid and of a goat. The odour of caproic acid is less goaty, and that of caprylic acid resembles perspiration. A curious relation exists between the formulæ of these several acids, the carbon and hydrogen successively increasing by the addition of 4 equivalents, as shown in the following table: —

Butyric acid . .	$C_8\ H_7\ O_3,\ HO$
Caproic „ . .	$C_{12}\ H_{11}\ O_3,\ HO$
Caprylic „ . .	$C_{16}\ H_{15}\ O_3,\ HO$
Capric „ . .	$C_{20}\ H_{19}\ O_3,\ HO$

Capriccio (Ital. *whim, fancy*). In Music, a term applied to certain pieces, wherein the composer gives way to his fancy, without confining himself to particular measures or keys; they are also called *Fantasia*.

Capricorns (Lat. capricornus). The name of one of the three divisions of Tetramerous beetles; including those which have the antennæ filiform or setaceous, and generally exceeding the length of the body; eyes lunate, and enclosing the base of the antennæ; jaws very robust, with short palpi; thorax often spined at the sides; the three basal joints of the tarsi dilated, and cushioned on the under surface; the third deeply cleft at the extremity, and receiving the minute ball at the base of the slender and long terminal joint. This division comprehends four great families—*Prionidæ*, *Cerambycidæ*, *Lamiidæ*, and *Lepturidæ*; and corresponds very nearly with the Linnæan genera *Cerambyx*, *Necydalis*, and *Leptura*. The offices of the capricorn beetles in the economy of nature is to restrain the excessive multiplication of vegetable species in the warmer climates of the globe. The larvæ reside within the wood or beneath the bark of trees.

Capricornus (Lat. *The Wild Goat*). The tenth sign of the Zodiac, which the sun enters about the 21st of December, at the winter solstice. The parallel circle passing through the first point of this sign is called the *Tropic of Capricorn*.

Caprification (Lat. caprificatio). A fertilisation of flowers by the aid of insects, in the way which occurs in the case of the fig, by means of a small fly.

Caprifoliaceæ (Caprifolium, one of the genera). A rather large natural order of Exogenous plants, belonging to the Cinchonal alliance, and having exstipulate leaves, epipetalous stamens, straight anthers bursting longitudinally, and consolidated fruit. They consist of twining and erect shrubs, and herbaceous or woody plants, and even of trees, with simple or pinnated leaves, and flowers of most dissimilar forms, but all monopetalous. The most common plants belonging to this order are the Woodbine, the St. Peter's Wort, the Tartarian and Fly Honeysuckle, the numerous species of Viburnum, and the Elder-tree.

Caprifolium (Lat. capra, *a goat*, and folium, *a leaf*). The genus to which the wild Honeysuckle (*C. Periclymenum*) belongs. It consists of twining shrubs inhabiting the northern hemisphere exclusively, and in most cases having long tubular flowers of singular sweetness. Many species are known to botanists, the most interesting of which are those from the north of India, China, and Japan, the fragrance of which is superior to that of all others.

Caproic Acid (Lat. capra, *a goat*). One of the acids formed during the saponification of butter; it has a rank goat-like odour.

Caproic Alcohol. A colourless aromatic volatile liquid occurring in small quantity in brandy.

Caprollene. A light colourless liquid of unpleasant odour. It is a frequent product of the destructive distillation of fatty bodies.

Capromys (Gr. κάπρος, *a boar*, and μῦς, *a mouse*). The name of a genus of Rodent Mammalia, exclusively confined to the island of Cuba, where they go by the name of Hútias. They have four molars on each side of the jaw, in which the enamel is so folded as to form three angles on the outer margin and one

on the inner, in the upper teeth; the reverse in the lower teeth. The liver is remarkably subdivided in the rodents of this genus.

Capros (Gr. *a boar*). A name applied by Lacépede to a subgenus of Acanthopterygious fishes, which he separated from the dories (*Zeus*), and of which the boar fish (*Zeus Aper*, Linn.) may be regarded as the type. A specimen of this fish has been taken at Mount's Bay, and another near Bridgewater, but it is rare as a British species.

Caprylic Acid. A constituent of butter and other fats. It is most easily prepared from cocoa-nut oil. At ordinary temperatures it is a liquid, but at 50° crystallises in needles.

Caprylic Alcohol. The *hydrated oxide of capryl.* A colourless volatile liquid of agreeable odour: obtained on distilling castor oil with caustic potash.

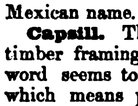
Capsicine. An acrid soft resin found in the fruit or seed pods of the *Capsicum annuum*; it appears to be the acrid principle of Cayenne pepper.

Capsicum. A genus of *Solanaceæ*, consisting of annual or sub-shrubby plants, with a wheel-shaped corolla, five convergent protruding anthers, and a two to four celled ovary becoming a membranous pod or seed-vessel of varied form. The seed-vessels of different species, namely the larger ones of *C. annuum*, and the smaller ones of *C. frutescens* and *C. baccatum* or Bird-pepper, as well as those of other species, form, when powdered and sifted, the Cayenne pepper of commerce, so well known as a powerful condiment, and often useful as a stimulating medicine. Cayenne pepper is often grossly adulterated with common salt, and occasionally red lead and earthy powders are said to be added to it: it often has a disagreeable rancid odour, owing to its being sprinkled with oil to prevent its dust affecting those who prepare it. The fruit of the various species is often called Chili, from Tchitli, the native Mexican name.

Capsill. The upper horizontal beam in the timber framing of viaducts or bridges: this word seems to be incorrectly used for 'sill,' which means properly the bottom piece of a framing, but the other application of the word has become sufficiently general to warrant its being noticed.

Capsquares. The metal fastenings which keep the trunnions of a gun in their places on the carriage.

Capstan (Fr. cabestan: the word is connected by Mr. Wedgwood, *Dictionary of English Etymology*, with the old Spanish cabra, *an engine for throwing stones*, and with the Latin capra, *a goat*, applied to machines for raising weights). A strong massive piece of timber round which a rope is coiled, and being turned by means of bars, or levers, it affords an advantageous mode of applying power to overcome an obstacle. The capstan is chiefly employed in ships, where it is used for weighing anchor, hoisting sail, &c.; it is generally placed vertically, the lower end resting on a pivot, let down and firmly bolted through the deck of the ship, and the levers inserted in holes in the head or top, so that the force of the men working the capstan may be exerted continuously, and that there may be no necessity for removing the levers from one hole to the other, as is the case when the machine is placed horizontally, as in the French 'chèvre,' used for hoisting heavy loads quickly. The power of the capstan may be materially increased by the adoption of a system of wheelwork, an improvement which has been for several years applied in the mercantile and royal navies.



Capsular Ligaments. Those ligaments which surround movable articulations and retain the synovia, as in a bag.

Capsule (Lat. capsula, dim. of capsa, *a box* or *case*). In Anatomy, a membranous sac investing an organ, as the capsule of the liver, the spleen, &c. Those flask-shaped sacculi from which the uriniferous tubes commence are called 'capsules of Malpighi:' they surround the capillary glomerules or plexuses, called 'corpuscles of Malpighi.'

Capsule. In Botany, a term applied to all dry fruits which are dehiscent, whether they are many-seeded or few-seeded, simple or compound; and in such cases some expletive is added to indicate the particular nature of the fruit. Thus a capsule is *circumscissile* when cut round by a circular line dividing it into two parts; *siliquiform*, when long and taper, like the pod of a mustard-plant; *baccate*, when the pericarp is succulent; and *tricoccous*, when a dry capsule bursts into three separate closed pieces. Sometimes, for special carpological purposes, the word is limited in its application to such dry compound fruits as open by valves, and have an indefinite number of seeds; as in *Digitalis*, *Scrophularia*, the common lilac, &c.

Capsule. In Chemistry, a small shallow evaporating vessel or dish.

Captain (Fr. capitaine; Ger. hauptmann, *a headman* or *chief*). In the Army, the commander of a troop of cavalry or of a company of infantry or battery of artillery. The price of a captain's commission is different in the different branches of the British service: in the life guards, for instance, it is 3,500*l.*; in the cavalry, 3,200*l.*; in the foot guards with the rank of lieutenant-colonel, 4,800*l.*; in the infantry, 1,800*l.* The full pay of a captain in the life and foot guards is 15*s.* a day, in horse regiments 14*s.* 7*d.*, and in the infantry 11*s.* 7*d.*

Captain. In the Royal Navy, is the title of the officer next in rank below a flag officer. The title of post-captain, which was the proper rank of captain, and answered to colonel in the army, has been for some time in disuse. The captain is next in rank above the commander: he rises by regular succession to the rank of rear-admiral; under the condition, however, that he must have served six years in a sea-going vessel with the rank of captain. The senior captain on any station where there is

no admiral, has the rank of commodore. The pay of a captain varies by seniority from 30*s.* to 20*s.* a day, with command money ranging, according to the rating of his ship, from 12*s.* to 5*s.* a day. His half-pay begins at 10*s.* 6*d.* a day, and rises by seniority to 14*s.* 6*d.* a day. A captain in the navy ranks with a lieutenant in the army, until he has held the rank three years: and after that time with a colonel.

The heads of small parties or gangs of men in certain stations of the ship are also called captains; as of the forecastle, the tops, &c.

Caption (Lat. captio). In Law, a certificate signed by commissioners, to testify their execution of any commission in law or equity. Also, the act of taking a man into arrest. The caption of an indictment is the designation of the style of the court before which the jurors make their presentment.

Capuchins. [ORDERS, RELIGIOUS.]

Caput Mortuum (Lat.). The inert residue of the distillation and sublimation of different substances. When sulphate of iron, for instance, or green vitriol, is distilled at a red heat, it leaves a residue of red oxide of iron, which the old chemists called *caput mortuum vitrioli.* These residuary products were represented in alchemical writings by the symbol of a death's head and cross-bones.

Capybara. In Zoology. [CAPIBARA.]

Car (Lat. carrus, Fr. char). Any rude cart. The Irish car is a one-horse cart, with very low broad wheels, used for carting out manure and carting home grain in the case of soft peaty soils. The Irish jaunting car is a kind of one-horse chaise, commonly without springs, in which the people sit back to back, and with their faces looking sideways.

Carabidæ (Lat. carabus; Gr. κάραβος, *the stag-beetle*). A family of Pentamerous beetles, characterised by having a bilobed upper lip, smooth jaws (maxillæ), an entire tooth in the centre of the notch of the mentum or chin-process, and dilated tarsi in the males. The majority of the British species have the elytra soldered together. The *Carabidæ* generally defend themselves by discharging from the extremity of the body an acrid fluid, and emit a fetid odour. They are amongst the most ravenous of beetles, and prey on other insects, for which they lurk beneath stones, the bark of trees, &c.

Carabine or **Carbine** (Fr. carabine, Ital. carabino). A firearm used by cavalry and artillery, shorter in the barrel than the infantry musket or rifle. The 6th Dragoon Guards, from their having in early times been armed with this weapon, are called 'The Carabineers.'

Carabine-à-tige (Fr.). Is a rifle used in the French service, which has an iron pin fixed at the end of the breech in the line of the axis: on this, the bullet, which is elongated, is forced down by a hard blow of the ramrod, and so expanded into the grooves.

Caractères de Civilité (Fr.). In Printing, cursive characters invented and used by the printer Granjon, of Lyons, in the middle of the sixteenth century. Béranger de la Tour's *L'Amie des Amies* is an example of this kind of type.

Caradoc Sandstone. A deposit originally described by Sir R. Murchison as one of the principal members of his lower Silurian series, but now subdivided and less important. The lower and larger member passes into the LLANDEILO FLAGS, which are exceedingly rich in fossils, and the upper member is found to lie in many places unconformably on the lower. This upper member includes the *graptolite schists* of Sweden, the *Ungulite beds* of Russia, the *Ampelite* schists of Brittany, &c. All these deposits are singularly rich in TRILOBITES.

Caragana (Carachana, the Mogul name). A genus of pretty hardy Leguminous shrubs, inhabiting the Russian dominions in Asia. *C. arborescens*, *Altagana*, and *Chamlagu* are common in the shrubberies of this country, where they flower in the months of June and July. *C. jubata* is a singular scrubby plant, with the branches closely covered by the leafy spiny ragged petioles. The leaves of *C. arborescens* are said to contain a blue colouring matter like indigo.

Carageen or **Carrageen.** The Irish name of *Chondrus crispus* and other similar *algæ*, of which large quantities are collected for feeding cattle and for making jelly for invalids.

Caraipa (Caraipe, the name of one of the species in Guiana). The celebrated balsam of Tamacoari, a substance of the colour of old port wine and the consistency of olive oil, and of great utility in the cure of the itch, is the produce of *C. fasciculata*, one of several South American species of the genus of *Ternströmiaceæ*.

Caraites. A sect among the Jews who adhere closely to the text and letter of the Scriptures, rejecting the rabbinical interpretations and the Cabbala.

Carambole. [BILLIARDS.]

Caranna. A resin brought from South America, of an aromatic odour; formerly used in plaisters.

Caranx (derivation unknown). A genus of spiny-finned fishes, belonging to the *Scomberidæ* or mackerel family; but differing from the true mackerel in having a series of scales, with ridges or keels in the middle, ranged along the lateral line. From this resemblance they are commonly termed 'bastard mackerel.'

Carapa (Carib. Carapa, applied to one of the species). A genus of *Meliaceæ*, found in the West Indies and tropical America. *C. guianensis* is a large tree of Guiana. Its bark is febrifugal, and used for tanning. Its timber, called crab-wood, is employed as mast-spars, shingles, &c.; and the oil of its seeds, called carap or crab-oil, is used for burning in lamps and other purposes. In this country it hardens into a solid fat. The seeds of *C. guineensis*, a native of tropical Africa, yield Coondi or Tallicoonah oil, which is purgative and anthelmintic.

Carapace (Fr.). The upper shield or plate of the armour or shell of the tortoise and

crab. Callipash is a corrupt form of this word.

Carapine. An alkaloid found in the *Carapa guianensis.*

Carasse. The bony vault which protects the upper part of the body of the Chelonians, or tortoises and turtles, and which results from the union by suture of the dilated and flattened parts of the vertebræ and ribs, intercalated with bones from the dermoskeleton. The analogous part of the body of the crab is also called Carasse; but this is not composed of corresponding parts to those of the tortoise, but of a calcified integument. The term CARAPACE is also used [which see].

Carat (a word of doubtful origin). A carat is a weight of 4 grains, used in weighing diamonds. The term Carat is also used in reference to the fineness of gold; in expressing which, the mass spoken of is supposed to weigh 24 carats, of 12 grains each; and the pure gold is called *fine.* Thus, if gold be said to be 22 carats fine (or standard), it is implied that 22-24ths are pure gold, and 2-24ths alloy. In the process of assaying gold, the real quantity taken is very small, generally from 6 to 12 grains; and this is termed the *assay pound.* It is subdivided into 24 carats, and each carat into 4 assay grains, and each grain into quarters; so that there are 384 separate reports for gold. When the gold assay pound is only 6 grains, the quarter assay grain only weighs 1·64th of a grain. This will give an idea of the accuracy required in the weights and scales used for such delicate operations. [ALLOY and ASSAY.]

Caravan (a Persian word). A company of merchants, travellers, or pilgrims, who associate together in many parts of Asia and Africa, that they may travel with greater security through deserts and other places infested with robbers or exposed to other dangers. The commercial intercourse of Eastern and African nations has from the remotest ages been carried on chiefly by means of caravans, as the governments that have sprung up in those continents have seldom been able, even if they had had the will, to render travelling safe or practicable for individuals. Since the establishment of the Mohammedan faith, religious motives, with others of a less exalted character, have tended to augment the intercourse between different parts of the Eastern world, and to increase the number and magnitude of the caravans. Mohammed, as is well known, enjoined all his followers to visit Mecca once in their lifetime; and large caravans assemble for this purpose in every country where the Mohammedan faith is established. There are four regular caravans which proceed annually to Mecca: the first from Damascus, composed of pilgrims, travellers, and merchants, from Europe and Asia; the second from Cairo, for the Mohammedans of Barbary; the third from Zibith, near the mouth of the Red Sea, where those of Arabia and India meet; the fourth from Babylon, where the Persians assemble. Every caravan is under the command of a chief or aga (caravanbachi), who has frequently under him such a number of troops or forces as is deemed sufficient for its defence. When it is practicable they encamp near wells or rivulets, and observe a regular discipline. Camels are almost uniformly used as a means of conveyance, in preference to any other animal, on account of their wonderful patience of fatigue, and their peculiarity of structure, which so admirably fits them for travelling through desert wastes. [CAMEL.] For further details on the subject of caravans, the reader may consult M'Culloch's *Commercial Dictionary* and the authorities there referred to.

Caravansary (Pers. serai, *a house* for caravans). A large public building, or inn, for the reception and lodgement of caravans in the desert. Though serving instead of inns, there is this essential difference between them, that the traveller finds nothing in the caravansary for the use either of himself or his cattle, but must carry all his provisions and necessaries with him. Caravansaries are also numerous in cities, where they serve not only as inns, but as shops, warehouses, and even exchanges.

Caravel (Span. caravela). A light ship formerly used by the Spaniards and Portuguese; also a vessel used by the French in the herring fishery.

Caraway. The carminative fruit or seed of the *Carum Carui,* an indigenous umbelliferous plant. English caraways are more plump and aromatic than the Dutch or foreign, which are apt to be mouldy and of little flavour. They yield about 3 per cent. of essential oil when carefully distilled with water. They are a good addition to purgative and other remedies, to prevent griping and flatulency; but their chief consumption is among gingerbread bakers, confectioners, and pastrycooks.

Caraway, Oil of. An aromatic volatile oil, obtained on distilling the crushed seeds of the *Carum Carui* with water. It is used as a flavouring agent.

Carbamide. A compound of carbonic oxide and amidogen, contained, according to Regnault, in chlorocarbonate of ammonia: its chemical formula is CO, NH_2.

Carbanilic Acid. *Anthranilic Acid.* A crystalline body derived from indigo by the action of caustic potash.

Carbanilide. Carbamide in which hydrogen is replaced by phenyl. A white, volatile, crystalline body.

Carbazotic Acid. A crystallisable acid and bitter substance, composed of carbon, azote, and oxygen; obtained by the action of nitric acid on indigo and some other vegetable and animal substances. It is the bitter principle of Welter.

Carbethylic Acid. *Carbovinic acid* or *ethylcarbonic acid.* An organic acid produced when carbonic acid is passed into alcoholic solution of potash.

Carbobenzoic Acid. A derivative of cinnamein said to differ from benzoic acid.

Carbolic Acid. A substance obtained by the distillation of coal-tar: it crystallises in prismatic needles, which fuse at 95° and boil at 270°: it has a penetrating odour and burning taste, and in many respects resembles creosote: its specific gravity is 1·06. It appears to be identical with the substance called *hydrate of phenyl.* Its formula is $C_{12} H_5 O, HO$.

Carbomethylic Acid. Obtained as carbethylic acid, wood spirit replacing vinic alcohol.

Carbon (Lat. carbo). This term is used in Chemistry to signify the pure combustible base of the varieties of charcoal and other carbonaceous matters; the diamond is pure carbon in a crystalline form. Carbon is an elementary substance, which combines with oxygen in two proportions, forming *carbonic acid* and *carbonic oxide.*

Carbonates. Salts containing carbonic acid. They are recognised by the effervescence which is excited when they are put into dilute muriatic acid. *Carbonate of lime* is one of the most important of these compounds, forming the varieties of marble, limestone, calcareous spar, chalk, &c. Carbonate of lime consists of

Lime	1 atom	= 28	56
Carbonic acid	1 atom	= 22	44
	1	50	100

Carbonate of potash and carbonate of soda are also important salts. [POTASH; SODA.] *Carbonate of ammonia* is used in medicine; it is a white pungent salt, commonly known under the name of *smelling salt. Spirit of hartshorn* is a solution of impure carbonate of ammonia, obtained by distilling bone or horn.

Carbonic Acid. This important compound is obtained when any form of carbon, such as the diamond or pure charcoal, is burnt in oxygen gas. It consists of 6 carbon + 16 oxygen = 22 carbonic acid; or of

Carbon	1 atom	6	27·27
Oxygen	2 atoms	16	72·73
	1	22	100·00

100 cubical inches of carbonic acid gas weigh 47·3 grains. Under a pressure of 36 atmospheres, at the temperature of 32°, it becomes liquid; and when the pressure which retains it in the liquid state is removed, the rapidity of the evaporation, and the sudden and enormous expansion of the vapour, are such as to produce a degree of cold under which the acid solidifies, forming a white concrete substance possessed of very extraordinary properties. Mr. Faraday was the first who liquefied carbonic acid, but it was first described as a solid by M. Thilourier.

At common temperatures and pressures water absorbs its own volume of carbonic acid; under a pressure of two atmospheres it dissolves twice its volume, and so on. Carbonic acid imparts briskness and a slightly pungent and sour taste to water impregnated with it; it also confers the effervescent quality upon many mineral springs. Carbonic acid is recognised by its rendering lime-water turbid. It extinguishes flame and suffocates animals; hence the miners call it *choke damp.* Carbonic acid is contained in marble, chalk, and all the varieties of limestone, from which it is extracted by strong heat, as in the process of *burning* lime; or by the action of stronger acids, in which case the carbonic acid escapes with *effervescence.* Mountains of limestone, therefore, are great natural repositories of carbonic acid. This gas is also produced during the respiration of animals, and is evolved in the process of fermentation.

Carbonic Oxide. A gas composed of

Carbon	1 atom	6	42·8
Oxygen	1 atom	8	57·2
	4	14	100·0

100 cubical inches weigh 30·2 grains. It is fatal to animals, and extinguishes flame; but it burns in contact with air, and forms carbonic acid. It is obtained by passing carbonic acid over red-hot charcoal; or by heating a mixture of chalk or pounded marble and iron or zinc filings to redness. It is not absorbed by water.

Carboniferous (Lat. carbo, *coal*, and fero, *I bear*). A Geological term generally applied to beds or strata containing coal.

Carboniferous System. The deposits thus named are among the most important of all the accumulations of mineral matter in the earth; for they include, in England, not only the great deposits of coal and iron, which are sources of national wealth of inconceivable magnitude, but some of our principal ores of lead and zinc, supplies of marble, an inexhaustible supply of limestone for building and burning, and a number of less important, though very valuable minerals.

There are two principal divisions of the carboniferous system. Both are characterised by the presence of an enormous quantity of carbon; but in one—the lower division— the carbon is in combination with oxygen and lime, forming masses of limestone derived chiefly from animals; and in the other—the upper series—the carbon is more nearly pure, and in the form of coal, the result of vegetation. [COAL.]

The chief characteristic of the lower and older member of the carboniferous system in England and Western Europe generally, as well as in North America, is a vast deposit of coralline limestone, crystalline for the most part, and abounding in shells, encrinites, and corals. It has long been known as the MOUNTAIN LIMESTONE, from its large developement in the mountain districts of Yorkshire, Derbyshire, and Lancashire, where it is the source of much picturesque beauty. [MOUNTAIN LIMESTONE.] Among the limestones are many bands of coal, some thick enough and good enough to pay for working. In other parts of England, and in Russia, very poor and imperfect coal measures represent the carboniferous limestone. In Ireland there is a peculiar sandy deposit of the same age.

Over the carboniferous limestone lies the MILLSTONE GRIT, a rock occasionally represented by bituminous shales and covered by pebbly grits. Here come in some of those valuable deposits of iron more common among the coal measures, but helping to give value to

the middle part of the carboniferous system. Here also are valuable building stones.

The natural divisions between the beds of limestone and its numerous crevices and caverns are often filled more or less completely with ores of lead and zinc. Rich masses of galena occupy the fissures, large deposits of calamine fill the interspaces between the beds, and where none of these valuable minerals exist, large bodies of water accumulate and occasionally make their way out in springs or are available when tapped by accident or intention.

Much of the carboniferous limestone is of organic origin, and appears to have been deposited in a coral sea, not far from islands covered with luxuriant vegetation. The almost perfect identity of species observable when fossils obtained from the quarries in Central Europe are compared with others from high northern districts either in Europe or North America, renders it highly probable that a remarkable uniformity of climate prevailed at that time over the whole northern hemisphere. The nature of the prevailing fossils—GONIATITES, ORTHOCERATITES &c. among the univalves, and the numerous species of TEREBRATULA and SPIRIFER among the bivalves—points to conditions different from any that have since affected the same districts.

Over the millstone grit come the sandstones and shales that contain the coal measures—the lower part of which in England is most prolific in coal. At least a quarter of a million of square miles of the earth's surface in the various tracts of land now above the water, are covered with sandstones and shales of the carboniferous period, among which coal is buried; and this coal is for the most part accessible. As in each square mile of country there are upwards of three millions of square yards of surface, and a cubic yard of coal weighs nearly a ton, while in many coal-fields there is an average of workable coal from ten to twenty yards thick, the reader may obtain for himself a rough but sufficient estimate of the possible extent of supply of this mineral. [COAL.]

Carboy. A large globular bottle of green glass protected by basket-work. Carboys are seldom used, except for containing certain acids and other highly corrosive liquids likely to act upon stoneware. A carboy of oil of vitriol usually contains about 160 lbs. of that acid, or twelve gallons of water. This word is identified by Dr. Latham with the Romaic *καραμπόγια*, the π being sounded as *b*, and the κ as *y*.

Carbuncle (Lat. carbunculus, *a small coal*). The name applied by jewellers to the variety of Precious Garnet which is cut *en cabochon*. It was a gem held in great estimation by the ancients. [ALABANDINE; PYROPE.]

CARBUNCLE. A hard circumscribed inflammatory tumour, which generally arises on the neck or back, soon forming a fetid discharge, and acquiring a tendency to gangrene. It is a kind of malignant boil, spreading under the skin, and producing a morbid inflammatory action of the surrounding parts. Poultices, and free incisions to let out the matter, and afterwards emollient fomentations, are the most effective remedies. This disease is also called *anthrax*, the Greek word for a coal.

Carburet of Sulphur. A liquid compound of carbon and sulphur, obtained by passing the vapour of sulphur over red-hot charcoal. It was formerly termed *alcohol of sulphur*. It forms compounds, which have been termed *carbo-sulphurets*.

Carburets. In Chemistry, the generic term for compounds of carbon with the simple combustibles.

Carburetted Hydrogen. Under this term two gaseous compounds of carbon and hydrogen are usually included: *light hydrocarbonate* and *olefiant gas*.

Light carburetted hydrogen is evolved abundantly in some coal mines, where it is known under the name of *fire damp*, and is the cause of those tremendous explosions which were so frequent before the invention of the safety lamp by Sir H. Davy. It is also evolved by the mud at the bottom of stagnant waters, where it results from the decay of vegetable matter. This gas is much lighter than atmospheric air, 100 cubical inches weighing between 17 and 18 grains. It burns with a yellow flame, is inodorous, and not absorbed by water. It consists of 6 carbon + 2 hydrogen. When mixed with three volumes of oxygen, or with eight or ten of common air, it explodes with great violence when inflamed, and produces water and carbonic acid.

Olefiant gas received its name from its property of forming, when mixed with chlorine, a liquid of an oily appearance. It is obtained by distilling a mixture of alcohol with twice its bulk of sulphuric acid, and may be collected over water, which, however, absorbs about one-eighth of its volume of the gas. It has a slight odour; it extinguishes flame; is unrespirable; burns with a dense white light; and when mixed with three or four volumes of oxygen, or ten or twelve of air, it detonates on the approach of flame with great violence. It is nearly of the same specific gravity as atmospheric air; and from the quantity of oxygen required to convert its elements into carbonic acid and water, it is shown to consist of two atoms of carbon and two of hydrogen, or of one volume of carbon vapour and two volumes of hydrogen, so condensed as to form one volume of olefiant gas.

Carcass (Fr. carcasse). A species of shell filled with a composition the flame of which is extremely powerful and nearly unextinguishable. Carcasses are much used in the bombardment of towns, for setting fire to shipping, &c. They can be fired from guns, mortars, and howitzers like common shells, from which they differ only in being cast thicker, that they may withstand the intensity of the fire of the composition, and having three vents instead of one fuse-hole.

Carceres (Lat.). In Architecture, the cells at the end of a circus in which were stationed the chariots and horses that contended for the prizes, so that they might be able to start simultaneously at the given signal.

Carceruli (Lat. dim. of carcer, *a prison*). A name given by botanists to such fruit as that of the lime-tree, which consists of a small number of dry indehiscent few-seeded cells cohering round a central axis.

Carcinoma (Gr. καρκίνωμα, from καρκίνος, *a cancer*). A cancerous tumour.

Cardamom (Gr. καρδάμωμον). The seeds of the *Elettaria Cardamomum*, which are imported from India. There are several varieties, but those pods which are small, short, thick, and heavy, are preferred. The seeds themselves are very pungent and aromatic, while the containing capsule is quite insipid. Their chief use is in medicine, especially in combination with cathartics and bitters. They yield an essential oil by distillation, to which their virtues are to be ascribed.

Cardan's Formulæ. [Cubic Equations.]

Cardiac (Gr. καρδιακός). Belonging to or connected with the heart. The superior opening of the stomach is called the *cardia*, or *cardiac end*, from its proximity to the heart.

Cardiadæ or **Cardiacea.** A numerous and beautiful family of lamellibranchiate dimyary bivalve molluscs, including those species in which the mantle is open anteriorly for the foot, and also has two distinct orifices, one for respiration, the other for excretion, as in the cockle (*Cardium edule*). The shell is characterised by having at the hinge irregular primary teeth, both in form and situation, and generally accompanied by one or two lateral teeth. The genera composing this family are *Cardium, Hemicardium, Lithocardium, Serripes, Adacna, Conocardium.*

Cardialgia (Gr. καρδιαλγία). Anxiety and pain about the region of the stomach, frequently attended by a sense of gnawing and heat, and hence called *heartburn.* It is a common symptom of indigestion, and accompanied by salt and acid eructations. After excess in eating and drinking, a fit of heartburn may often be prevented by a teaspoonful of carbonate of magnesia, taken in cinnamon or soda-water, at bed-time; twenty or thirty grains of bicarbonate of soda in cold chamomile tea is also an effective preventive. Where the disease is symptomatic of organic mischief, these antacid remedies must be cautiously administered.

Cardinal (Lat. cardinalis, from cardo, *a hinge*). An epithet implying importance; in which sense it is applied to the principal virtues, the four points of the compass, &c.; and in theological language originally to parish churches, as distinguished from chapels and oratories: whence it was transferred to the clergy who ministered in such churches. In later times the epithet was restricted to the seven bishops of Rome, and the sees within its territory, and the clergy of the eight-and-twenty principal churches of that city: whence the college of cardinals takes its origin. The number of which this college consisted has varied in the course of time. It has for some centuries been limited to seventy; of whom six are bishops of certain Roman dioceses; fifty, styled cardinal-priests, hold their titles from parishes in Rome (many of them being at the same time bishops of foreign dioceses); and fourteen are deacons. But in point of fact there are at present fifty-eight only. The election of the pope, which is performed by these personages assembled in conclave, is thus concurred in by the three orders of clergy through their representatives. The period at which this election was confined to the cardinals is variously stated. Some have asserted that such was the case as early as 1058; others, not before 1562. It is now understood that the pope must be chosen from this body. The cardinals are distinguished by a scarlet hat, and a short purple mantle worn over the rochet. Their rank is next to that of the pope, for whom they form a political council for the secular affairs of Rome; and also an ecclesiastical council, each *congregation* being presided over by one or more of the cardinals. Authentic information as to their rank and function may be found in the *Papal Calendar* (*Annuario Pontificio*), published annually at Rome. [Consistorium and Conclave.]

Cardinal Points (Lat. cardo, *a hinge*). In Geography, the east, west, south, and north points of the horizon. In Astrology, the cardinal points are those of the rising and setting of the sun, and the zenith and nadir. [Compass.]

Cardioid (Gr. καρδιοειδής, *like the heart*). An algebraic curve, so called from its resemblance to a heart. It is generated by adding to and subtracting from the radii vectores through a point in the circumference of a circle a portion equal to the diameter of the latter. Its polar equation therefore is

$$r = 2a\,(1 + \cos\theta)$$

if a be the radius of the generating circle. Its equation in rectangular coordinates may obviously be written in the form

$$\left[(x-a)^2 + y^2 - 3a^2\right]^2 = 4a^2\,(a + 2x);$$

whence it may be concluded that the curve is of the fourth order and third class, having three cusps, one at the origin and the other two at the circular points at infinity. The line $2x + a = 0$, parallel to the ordinate axis, is a double tangent, and the only one which the curve possesses. It has no proper double points or points of inflexion. Amongst other properties possessed by the cardioid, the following are worthy of note. It is the pedal of a circle with respect to a point on the circumference, and the inverse of a parabola with respect to the focus. It may be generated as an epicycloid by making a circle roll on the convex side of an equal circle; consequently, like all epicycloids, the evolute of a cardioid is itself a cardioid. Lastly, this remarkable curve is the

caustic by reflexion from a circle in whose circumference is a luminous point.

Carditis. Inflammation of the heart.

Cardoon. *Cynara Cardunculus.* A kind of artichoke.

Cards, Playing. Oblong pieces of pasteboard, inscribed with certain figures and points, and used in various games of skill and hazard. The origin of this invention is obscure. While it has by some been erroneously attributed to the Romans, by others it has been traced, perhaps with more plausibility, to an Asiatic source. The claim, advanced by Mezerai, on behalf of the French, is certainly untenable. Cards may have been used in France in 1390; but that they were not invented to amuse Charles VI. is evident, from the fact that they are mentioned in the Stadtbuch of Augsburg for the year 1275. Tiraboschi speaks of them as used in Italy before the close of the thirteenth century; and the game is noticed in many German books throughout the fourteenth century. The figures of the four suits were symbolical representations of the four great classes of men; and the names attached to these figures in this country arose from a misapprehension of the names originally assigned to them. Thus, by the *hearts* are meant the *gens de chœur* (cœur), the choirmen or ecclesiastics, and hence these are called *copas*, or chalices, by the Spaniards; whose word *espada*, sword, indicating the nobility and warriors of the state, has been corrupted into the English *spade*. The clubs were originally *trèfles*, trefoil leaves, and denoted the peasantry; while the citizens and merchants were marked by the diamonds (*carreaux*, square tiles). The word *knave* (Ger. *Knabe*, boy) was used, of course, in its older sense of servant, or attendant on the knights. The French cards long retained the names of the four kings, David, Alexander, Cæsar, and Charles, who marked respectively the Jewish, Greek, Roman, and Frank empires. The queens, Argine, Judith, Esther, and Pallas, are not so easily accounted for. The first name furnishes an anagram of *regina*, or queen; the others may have been chosen as types of the moral qualities of wisdom, purity, and courage.

A modern English pack of cards consists of fifty-two cards, in four *suits*—two red, *hearts* and *diamonds*, and two black, *spades* and *clubs*; each suit consisting of three *court* or *picture* cards, the king, queen, and knave, and ten other cards distinguished by the number of their 'pips' or spots, from ten to one respectively. The lowest of these is always called the 'ace,' and the two and three are often called the 'deuce' and 'tray.' The natural rank of the cards in each suit is, king highest, and so on down to ace lowest; but in many games this rank is varied, as in Whist, where the ace is put highest of all, above the king; in Écarté, where it is put between the knave and the ten; and in Bézigue, where it is made the highest, but where the ten is put between it and the king. In Quadrille, the rank of some of the cards is variable every hand. Sometimes the pack of cards is reduced to thirty-two, by excluding the six, five, four, three, two, of each suit; it is then called a 'piquet pack.'

An immense variety of games are played with cards, some involving chance only, some combining chance and skill, the best of them furnishing very agreeable and intellectual amusement. Some are *round games*, in which any number of persons may join, as *Vingt-un*, *Speculation*, *Loo*, *Pope Joan*, &c.; some are for four persons, as *Whist* (the best of all, and a very fine game), *Quadrille*; some for two, as *Piquet*, *Écarté*, *Bézigue*, *Cribbage*; and, lately, games have been introduced even for *one* person, called *Patience*. For descriptions of the several games, see these words.

Carduelis (Lat. carduus, *a thistle*). A genus of Conirostral Perchers (*Insessores*) or Passerine birds, of the finch tribe (*Fringillidæ*), including the goldfinch (*Carduelis elegans*), aberdevine (*Carduelis spinus*), and other British siskins, the habits of which are less arboreal than those of the true finches, and which feed principally on the seeds of the thistle and other composite plants. [CANARY-BIRD.]

Careening (Fr. carène, from Lat. carina, *the keel*). The laying of a ship over to get at leaks or injuries in the bottom. This is commonly called *heaving down*. To careen implies also to *heel* or lie over generally. Heaving down is never practised with a large ship, except where there are no docks, as the great force which must be applied to the mast-heads to get her over are liable to strain the hull.

Caret (Lat. *it is wanting*). In Grammar, a character in this form ‸, denoting that something has been omitted, and is interlined.

Cariama. [DICHOLOPHUS.]

Caribbean Sea. The southern portion of the great ocean gulf between North and South America is thus named. It is bounded by the north shores of South America and the shores of Central America as far as Yucatan, and beyond that by the coasts of Cuba and St. Domingo. To the east it is nearly shut in by the chain of the Antilles, terminating in Trinidad. It contains more than a million and a quarter square miles of water.

The Caribbean Sea receives some important rivers from South America. It has also a marine current which sets into it from across the Atlantic. Its waters accumulate, owing to the set of this current, and are forced to pass into the gulf of Mexico, whence they can only escape by the narrow passage between Florida and the Bahama reefs [MEXICAN GULF], thus forming the GULF STREAM.

The Caribbean Sea is entirely intertropical: its waters are very warm, and its depth is generally between 500 and 1,000 fathoms. It contains the important island of Jamaica. There are no coral reefs in it, except along part of the south coast of Cuba. Its bed is occasionally disturbed by earthquake action.

Carica. The Papaw-tree, *C. Papaya*, is the most remarkable species of this genus of

Papayaceæ, and is a small tree, with a soft spongy stem, large deeply-lobed leaves having gashed segments, and unisexual flowers succeeded by oblong dingy yellow fruit. Throughout the West Indies the juice of this tree, or an infusion of its fruit or leaves, is reputed to possess the remarkable property of causing a separation of the muscular fibre of animal flesh, and thus rendering the toughest meat tender. The unripe fruit is pickled, the ripe fruit preserved in sugar.

Caricature (Ital. caricatura, from caricare, *to load* or *overcharge*). In Painting, an exaggerated representation of any object, in which any natural defects are overcharged, so as to make it appear ridiculous.

Carichium (Lat. carex, *sedge*). A genus of land snails, so called from their habitat among sedge, wet leaves, grass, &c. Of these sedge-shells, *Carichium minimum* is British, and may be found about Acton.

Caries (Lat.). A decayed bone or tooth.

Carillon (Fr.). A tune performed upon bells.

Carina (Lat. *the keel of a boat*). In Botanical language, the sharp thin back of any organ. The back of a leaf folded up, if thin and sharp, the winged rim that occupies the back of certain fruits, and the sharp-backed part of a glume or bract, all bear this name. It is also applied to the two anterior petals of a Papilionaceous flower, which adhere by their lower edges into a body something like a boat.

Carinaria (Lat. carina). A genus of Heteropodous Molluscs, characterised by having the principal viscera, comprising the heart, liver, branchiæ, generative organs, &c., protruded from the body, and encased in an extremely fragile, beautiful, sub-transparent, symmetrical, compressed shell. The summit of the shell is slightly involuted, but never enters the aperture; the convexity of the shell is terminated by a single keel.

Carinate (Lat. carina). In Zoology, when a surface has a longitudinal elevated line, like the keel of a vessel.

Carinthine. A ferruginous and aluminous kind of Hornblende, from the Sau-alp in Carinthia. It occurs massive and disseminated, of a black or greenish black colour, opaque, with a lustre which is resino-vitreous externally, but internally splendent.

Carinthite. [WULFENITE.]

Carlings. In Shipbuilding, are short beams running fore and aft, with their ends scored into the great transverse beams. They aid in sustaining the deck, and in binding the principal beams together.

Carludovica (in honour of Charles IV. of Spain, and his queen Louisa). The hats known as Panama hats are made from the leaves of *Carludovica palmata*. Those of the best quality are plaited from a single leaf without any joinings, and as the process sometimes occupies two or three months, the price is very high. The leaves are cut while young, and the stiff parallel veins removed, after which they are slit into shreds but not separated at the stalk end; they are then immersed in boiling water, and bleached in the sun. *Carludovica* is a small genus of *Pandanaceæ*, confined to tropical South America.

Carmelite. [ORDERS, RELIGIOUS.]

Carmidine. An alkaloid contained in the distillate of shale-tar.

Carminatives. Medicines which allay flatulency, and pain of the stomach and bowels, arising from it.

Carmine. A brilliant lake, made of the colouring matter of the cochineal insect combined with alumina and a little oxide of tin.

Carmine Spar or **Carminite.** An anhydrous arsenate of lead and iron, occurring in translucent needle-shaped crystals, and in spheroidal forms with a columnar structure, at Horhausen in Saxony. The name has reference to the colour of the mineral, which varies from carmine to tile-red.

Carminic Acid. *Cochinellin.* The pure colouring matter of the cochineal insect. It combines with bases forming uncrystallisable salts.

Carnallite. A hydrated chloride of potassium and magnesium which occurs in coarse granular masses mixed with the rock-salt of Stassfurth, near Magdeburg in Prussian Saxony. A deposit of this salt has recently been found at Stassfurth, overlying the rock-salt of the Zechstein formation. Carnallite is used as a fertiliser of the soil, and is named after M. von Carnall.

Carnat (Lat. caro, carnis, *flesh*). The name given by Breithaupt to a red variety of Lithomarge from Rochlitz in Saxony.

Carnation (Lat. caro, carnis, *flesh*, from their colour). A favourite garden plant, obtained by the florist's art from the wild *Dianthus Caryophyllus*. Its flowers are deliciously fragrant; and although in the unimproved state they are of a uniform deep red, they have been rendered beautifully striped and variegated by successive changes in the hands of the breeder. Carnations are arranged in three classes, *flakes*, *bizarres*, and *picotees*: the first have two colours in their flowers, and broad stripes; the second have irregular spots and stripes, and not fewer than three colours; the last have a broad or narrow edging of scarlet, red, or purple, upon a white or yellow ground.

Carnations. In Painting, the parts of a picture which represent the naked limbs, &c.

Carneia (Gr.). A festival observed in most of the cities of Greece, and especially at Sparta, in honour of Apollo, surnamed Carneius.

Carnelian (Lat. carneus, from caro, *flesh*). A variety of Chalcedony, generally of a clear bright-red tint, and passing into common Chalcedony through greyish red gradations. The change is insensible from red to white Carnelian through flesh-red and blood-red, with a greater or less admixture of brown to orange and various tints of yellow.

The finest specimens are brought from Arabia, and from Cambay and Surat in India.

Both in ancient and modern times it has been much used for seal-stones, beads, and other ornaments. (Bristow's *Mineralogy*, art. 'Carnelian,' p. 64.)

Carnival (Ital. carnavale). A festival celebrated with much merriment and revelry in Catholic countries, and especially at Rome and Venice, during the week before the commencement of Lent; deriving its Italian name probably from the farewell to flesh or meat which introduces the great fast of the church.

Carnivora (Lat. *feeding on flesh*). The second tribe of Cuvier's order *Feræ* (*Carnassiers*), including those species of which the teeth are peculiarly adapted for destroying living prey, and for tearing, dividing, or brushing flesh. They have incisors in each jaw, two long and pointed canines; and the molars are never beset with small conical points or tubercles, as in the insectivorous tribe of the same order. The carnivorous tribe is divided into those which tread on the sole of the foot (*Plantigrades*), and those which run on the last joints of the toes (*Digitigrades*).

Carob-tree. The Algaroba or Locust-tree, *Ceratonia Siliqua*. Its sweet and fleshy pods have of late years been largely imported for use as cattle food.

Carocolla (a word made up of the Lat. caro, *flesh*, and Gr. κόλλα, *glue*). A genus of land-snails, so named from the tenacity with which their fleshy foot adheres to limestone rocks. The variegated carocolla (*Car. lapicida*, Lam.) is a native species, and has been found on Juniper Hill, Box Hill, Surrey.

Carolathine. A mineral somewhat resembling Mellite, found in a bed of mineral coal at the Königen-Louise mine near Gleigwitz in Upper Silesia. It occurs in rounded balls or massive, of a colour passing from honey-yellow to wine-yellow, and is subtranslucent, has a faint greasy lustre, and is very brittle.

Named after the prince of Carolath.

Caromel. Sugar melted till it acquires a brown colour and exhales a peculiar odour.

Carotid (Gr. καρωτίδες). An artery of the neck. There is one on each side of the cervical vertebræ which supply the head with blood. If these vessels are tied, the animal becomes insensible; hence the term, from καρόω, *I put to sleep*.

Carotine. A deep red crystallisable substance contained in carrots.

Carp. [CYPRINUS.]

Carpadelium (Gr. καρπός, *fruit*, and δῆλος, *plain*). A little-used name, applied in Botany to indehiscent, many-celled, inferior fruits, with a single seed in each cell; as in Umbelliferous or Apiaceous plants.

Carpal Bones (Lat. *carpus*, wrist). The bones of the wrist. They are named as follows: First row, *scaphoides*, *lunare*, *cuneiforme*, *pisiforme*. Second row, *trapezium*, *trapezoides*, *os magnum*, and *unciforme*. They are formed in an arch, so as to resist accidental fracture.

Carpathians. This singular mountain chain forms a crescent-shaped ridge, which extends east and north of the course of the Danube, whose river valley chiefly separates the mountains of this group from the eastern continuation of the Alps on the one side, and from the westernmost extension of the Caucasus on the other. [ALPS and CAUCASUS.]

The Northern Carpathians and also the Eastern mountains are lofty dividing ranges, and attain an elevation exceeding 8,000 feet, which is about the snow limit in this part of Europe. These separate Hungary from Poland, and the plains of the Danube from those of the Dneister. They are wall-like, with only a few comparatively high passes, and form a continuous chain.

The southern part of the Carpathian chain extends to the left bank of the Danube, the river crossing the chain by a very deep gorge, and the mountain continuing towards the Adriatic. This part of the chain is less lofty than the northern part, but has two picturesque mountains which are covered with snow till long past midsummer.

The Carpathians are poor in botanical interest, but rich as a zoological province. They also abound in minerals.

Carpel (Gr. καρπός, *fruit*). A name contrived by modern botanists to denote the separate pistils out of which a fruit, consisting of more pistils than one, is composed. In its most simple state a fruit consists of a one-celled ovary, and a style and stigma, united into a pistil, as in the plum; but in most cases several such pistils are formed within the same flower, and are united in various ways into one compound body, to which the name of pistil is also applied. In the latter case the single pistils are called carpels. The pistil may nevertheless consist of one carpel only. The theory of the structure of the fruit of plants turns upon the relative position which carpels bear to each other in their united state; and upon their correspondence in this respect with leaves, of which they are undoubtedly modifications.

Carpenter (Fr. charpentier, Lat. carpentarius, *a wheelwright*, from carpentum, *a car*). The workman who practises the art of shaping and framing timber used in the construction of buildings, such as piles, sleepers, posts, girders, joists, partitions, roofs, battening, and the application of the necessary ironwork. The other part of the timberwork in a building comes within the province of the JOINER [which see].

Carpenter in a ship's company is the third warrant officer on board a man-of-war, and he has charge of the boats; it is his duty, in conjunction with his mates, to attend constantly to the state of the well in order that a leak may be immediately reported.

Carpentry. In Architecture and Building. Carpentry means the assemblage of pieces of timber connected by framing, or letting them into each other, as are the pieces composing a roof, floor, centre, &c. It is distinguished from Joinery by the fact that the pieces of timber are put together without the use of other edge tools than the axe, adze, saw, and chisel; whereas joinery requires the use of the plane; the

distinction is, however, very artificial, as all wrought timber is planed. The leading conditions to be attended to in sound carpentry are: 1. The quality of the timber used; 2. The disposition of the pieces of timber, so that each may be in such direction, considered with reference to the fibres of the wood, as to be most capable of performing its office properly; 3. The forms and dimensions of the pieces of timber employed; and 4. The manner of framing the pieces into each other, or otherwise uniting them by means of iron or some other metal. Nicholson divides the art of carpentry into *mechanical*, which treats of the nature and properties of woods, and the strains to which they may be submitted by their arrangement and disposition; *descriptive*, which consists in discovering the forms to be given to the different kinds or descriptions of timber; and *constructive*, which treats of the various practical methods of reducing the timbers and joining them where required. The best treatises on Carpentry are those of Nicholson, Robisson in his *System of Mechanical Philosophy*, *Tredgold* by Barlow; Kraft; and Emy, *Traité de la Charpenterie*, &c. &c.

Carpet (Ital. carpetto). An ornamental covering for the floor. The manufacture of carpets is carried on in great perfection in this country. The principal varieties are the Brussels, Axminster, Wilton, Kidderminster, and Venetian. They are generally composed of linen and worsted. In some the pile is cut so as to give the carpet the character of velvet, as in the Wilton carpets. Kidderminster or Scotch carpets are entirely fabricated of wool.

Carpet Way. Any strip or border of green sward left round the margin of a ploughed field.

Carpholite (Gr. κάρφος, *a dry stalk*, and λίθος, *stone*). A hydrated silicate of alumina, manganese, and iron, found at Schlackenwald in Bohemia. It occurs in tufts of minute rhombic prisms, of a straw-yellow colour; also massive, radiated, and earthy.

Carphosiderite (Gr. κάρφος, and σίδηρος, *iron*). A very rare straw-coloured mineral with a resinous lustre and a greasy feel, found in kidney-form masses and incrustations in the mica-slate of Labrador and Greenland. It has recently been analysed by F. Pisani, who pronounces it to be a hydrated sulphate of peroxide of iron.

Carphostilbite (Gr. κάρφος, and Stilbite). A straw-yellow and columnar variety of Thomsonite, from Berufiord in Iceland.

Carpobalsamum (Gr. καρποβάλσαμον). The exudation of the fruit of the *Balsamodendron gileadensis*, a variety of balm of Gilead.

Carpolites (Gr. καρπός, *fruit*, and λίθος, *a stone*). Fossil fruits and seeds.

Carpology (Gr. καρπός, *a fruit*, and λόγος, *discourse*). That part of Botany which treats of the structure of fruits and seeds.

Carpophorum (Gr. καρποφόρος, *fruitful*). The name of the central column, which, in the fruit of the *Geranium*, the *Euphorbia*, or Apiaceous plants, bears the ripe carpels, and holds them together when they attempt to separate at maturity.

Carpus (Lat.). In Anatomy, the segment of the skeleton of the upper or fore limb, answering to the wrist: it consists of eight small bones in the human subject.

Carrageenin. The vegetable jelly contained in Irish moss.

Carrel or **Quarrel** (Fr. carré, *square*). The arrow used in crossbows, the head of which was originally four-sided; a cross-bow bolt. Quarrels were the earliest projectiles fired from cannon.

Carrollite. A sulphide of copper and cobalt, of a tin-white colour inclining to steel-grey, occurring in a vein of Copper Pyrites at Finksburg, in Maryland, North America. It has a metallic lustre, and is named after the county (*Carroll county*) in which it is found.

Carronade. A short iron gun, which is attached to its carriage by a loop and bolt underneath the piece, instead of trunnions. It has less thickness of metal than other guns of the same calibre, and an enlargement or cup at the muzzle. As it admits only of a small charge of powder, its range is very confined: hence ships armed only with carronades have been beaten by vessels of nominally smaller armaments, composed of long-range guns. Carronades have thus become nearly obsolete. They were first introduced in 1779, by the director of the Carron foundry in Scotland.

Carrot (Fr. carotte). An esculent used both as a vegetable and for the purpose of cattle feeding. The cultivated carrots are improved succulent varieties of *Daucus Carota*.

Cart (A.-Sax.). An open box, placed upon two wheels, and constructed with shafts, so as to admit of being drawn by one or more horses. In agriculture, carts are used for carting or carrying from one point to another soils, manures, and produce. For this purpose there are the close cart, single or double, that is, for one or for two horses; the corn cart, single or double, constructed of open work, and used for carrying hay, and for conveying corn in the sheaf from the field to the rickyard, &c.; and the stone or quarry cart, consisting of a strong bottom and low wheels, for conveying large stones. Besides these, there are the three-wheeled cart, with low wheels, for carting soil, stones, &c. to a short distance; the timber cart, which is nothing more than two pairs of wheels and axles joined by a pole, and used for conveying large trunks of trees from the place where they have been felled to the place where they are to be manufactured; and the box cart, or cart with close bottom and sides, which is used for conveying soils, manure, and small articles, commonly constructed so as to admit of discharging the load by elevating one end of the box and lowering the other. To carts having this contrivance the term coup cart is applied in Scotland, and tilt cart in England.

Carte Blanche (Fr. *white paper*). A paper containing nothing but the signature of

the person who grants it, in order that the person to whom it has been delivered may insert such conditions as he chooses. This term is used in a general sense to express an unlimited authority delegated by anyone to another.

Cartel (Fr.; Ital. cartella, *pasteboard*, from Lat. charta, *paper*). In Military language, an agreement for the exchange of prisoners. Also, a challenge to fight a duel. A cartel ship is one commissioned, in time of war, to carry proposals of any kind between belligerent Powers.

Cartesian Coordinates. [COORDINATES.]

Cartesian Ovals. Certain curves of the fourth order and sixth class, whose properties were first investigated by Descartes. (*Œuvres de Descartes*, vol. v.) A Cartesian oval may be defined as the locus of the four intersections of those diameters of two given circles which pass through the points in which the circles are cut, by a secant through a fixed point in the line joining their centres. An equivalent, but more convenient definition, however, is the locus of a point, fixed multiples of whose distances from two fixed points (the centres of the above circles) give a constant algebraical sum. Hence if r_1 and r_2 be the variable distances, A and B the fixed points, m_1 and m_2 the invariable multiples, and d the constant sum, the equation of the curve may be thus written:

$$m_1 r_1 + m_2 r_2 = d.$$

This equation, expressed in rectangular coordinates and cleared of radicals, may be made to take the form $S^2 = k^2 L$, where $S = 0$ represents a circle, k a linear constant, and $L = 0$ a right line; whence it may be seen that the curve has two cusps at the circular points at infinity, a property which distinguishes the curve from all others of the same order, and a double tangent L, whose points of contact coincide with its intersection points with S. The curve has also in general eight points of inflexion, but no double point.

The first of the above equations shows at once that the conic sections are included in the family of Cartesian ovals; in fact the ellipse corresponds to the case of $m_1 = m_2$, the hyperbola to $m_1 = -m_2$, the given points A and B being in each case the foci. In the general case, the number of foci being always equal to that of the class [FOCUS], three foci coincide with the centre of the circle S, and two with the points A and B; the sixth C is also in the line containing the others, and has precisely the same properties as A and B, so that the equation of the same oval might also be written in the form

$$\mu_1 r_1 + \mu_3 r_3 = c^1,$$

or, by elimination, in the form

$$\lambda_1 r_1 + \lambda_2 r_2 + \lambda_3 r_3 = o.$$

Taking A as pole and AB as axis, the polar equation is obviously of the form:

$$r^2 + (a + b \cos \theta)\, r + c^2 = o,$$

where a, b, c can be easily expressed in terms of m_1, m_2, d. The product of the two roots of this equation being constant ($= c^2$), it follows that a Cartesian oval is its own inverse with respect to either of its three foci. Lastly, it is evident that Cartesian ovals include the *Limaçon* of Pascal ($c = o$), and hence also the Cardioid ($a = b$, $c = o$).

Recent investigations on Cartesian ovals have been made by Chasles, *Aperçu Historique*; Quetelet, *Nouveaux Mémoires de Bruxelles*, t. v.; Cayley, Liouville's *Journal*, t. xv. &c.; Salmon, *Higher Plane Curves*.

Cartesian Philosophy. The philosophical system of René Descartes (born 1596), a native of France, perhaps the most original thinker that country has produced. Descartes was the contemporary of Bacon, and exercised an equally powerful influence, though in a manner widely different, on the progress of philosophy in Europe. Both equally undertook the task of demolishing the old scholastic system, and of substituting in its place a more comprehensive method and a more living spirit. But what Bacon strove to accomplish by calling men's attention to experiment and observation of nature, Descartes proposed to attain by the search for a first and self-evident ground of all knowledge. This he finds in the act of consciousness, involving necessarily the idea of self or mind. (*Cogito, ergo sum.*) Consciousness is the act of thought, constitutes the essence of the soul, and is that which distinguishes it from matter. The ideas or objects of consciousness are of three kinds—acquired, compounded, and innate. Of the last sort is the idea of God, or the Absolute Being, which, as being the ground of all reality, is itself its own demonstration. God, the Author of the universe, upholds it in its course by His perpetual cooperation, or, in Cartesian language, assistance. All physical phenomena Descartes endeavoured to account for by his celebrated *vortices*—motions excited by God, the source of all motion. The singular mixture of philosophical depth and extravagant hypothesis that prevails in the writings of this philosopher obtained for him, as might have been expected, a large number of warm adherents, and of equally violent opponents. Among the former may be enumerated the celebrated Pascal, Malebranche, and Spinoza. The two latter deviated indeed in many important points from the views of Descartes; but the main features of his philosophy are preserved alike in the religious mysticism of the one and the systematic pantheism of the other.

Carthamine. The colouring matter of the *safflower*.

Carthamus. A genus of Composite plants, whose flower-heads are surrounded by numerous leafy buds in several rows, the outermost being broad and spreading with spiny edges, the middle ones erect, surmounted by an ovate appendage with spiny edges, and the innermost narrow entire and sharp pointed. The achenes have no pappus. *C. tinctorius* is the Safflower or Bastard Saffron, whose florets are extensively used for dyeing purposes, chiefly for silks. They are also used to adulterate saffron. [SAFFLOWER.]

Carthusians. In Ecclesiastical History, a religious order, instituted by St. Bruno in 1086; so called from their original seat, Chartreuse, near Grenoble in Vienne. They followed the rule of the BENEDICTINE MONKS [which see], of which it was in fact a reform, adding greatly to its austerities. Soon after their institution the Carthusians were introduced into England, where in the lapse of time they succeeded in establishing nine houses of their order, among which was the Charter-house in London. (*Histoire des Ordres Monastiques*, vol. vii.)

Cartilage (Lat. cartilago). A white elastic substance, intermediate between bone and ligament, and having the chemical properties of condensed albumen. It is commonly called *gristle*.

Cartilagineans. A sub-class of fishes, in which the endo-skeleton never passes beyond the primitive condition of gristle or cartilage. [CHONDROPTERYGII.]

Cartoon (Ital. cartone, *pasteboard* or *large paper*). In Painting, a sketch or drawing made as a pattern for fresco or tapestry. The name is given to the large sketches on coarse or other paper for fresco subjects; in which case, when the stucco is setting, the outlines are pricked through on to it so that a correct outline may be expeditiously obtained.

The Cartoons is a term especially applied to the seven celebrated compositions of Raphael, now preserved at Hampton Court. They were originally ten in number, and were made for Leo X. in 1515 and 1516 as patterns for tapestries which were hung on the lower parts of the walls of the Presbyterium in the Sistine chapel at Rome during church festivals. Raphael received about 15*l.* each for the cartoons; while the tapestries made from them at Arras cost 7,000*l.* They are still preserved at the Vatican, but are no longer used for church purposes. The series of designs illustrated the lives of the Apostles, five of them referring to St. Paul alone. The seven at Hampton Court were bought by Charles I. by the advice of Rubens, and some sets of tapestry were afterwards worked from them under the direction of Francis Cleyne at Mortlake for James II. They represent: The Miraculous Draught of Fishes, or the Calling of Peter; Christ's Charge to Peter; the Healing of the Lame Man at the Beautiful Gate of the Temple; The Death of Ananias; Elymas the Sorcerer struck blind; Paul and Barnabas at Lystra; and Paul preaching at Athens. They were preserved to the nation by Cromwell, who purchased them at the sale of King Charles's effects for 300*l.* They have been engraved by Dorigny, Fittler, Holloway, and John Burnet. Some of the original tapestries made after the cartoons are preserved at Ford Abbey in Somersetshire. (Wornum's *Epochs of Painting*, ch. xviii. 1864.)

Cartouch (Fr. cartouche; Ital. cartoccio). In Architecture, the same as MODILLION [which see], except that this term is used almost exclusively to signify the blocks or modillions applied at the eaves of a house. Some have used the term to denote the ornament of the key-stone of an arch, which seems to represent a scroll of paper partly unrolled.

Cartouche (Fr.). A case of leather or canvas for holding cartridges.

Cartridge. The exact charge of a musket, rifle, or fowling-piece, including both powder and bullet, or shot for sporting purposes, made up in a case, ready for loading. [SMALL-ARM AMMUNITION.] Also the charge of powder for a cannon made up in a bag of serge.

Carum. A genus of Umbellifers, one species of which, *C. Carui*, a biennial with finely cut leaves and compound umbels of white flowers, bears the caraway seeds used for flavouring purposes.

Caruncle (Lat. caruncula). A naked soft fleshy excrescence, often ornamenting some parts of the head of birds; as e. g. the caruncle on the cere of the king vulture (*Vultur papa*, Linn.).

Caruncula (Lat.). A small protuberance found near the hilum upon the seed of *Euphorbia Lathyris* and other plants.

Carvene. *Caruen.* A hydrocarbon derived from oil of caraway by distillation with caustic potash.

Carya (Gr. κάρυον, *a nut*). The genus of plants which includes the Hickory Nut of North America; a tree of the greatest value, for its tough elastic wood, as well as for the nuts, which resemble walnuts, except that their shell is not furrowed, and which are both eaten and pressed for their oil in their native country. There are several species of *Carya*; but *C. alba*, the White Hickory, a hardy ornamental tree in this country, is the most valuable.

Caryatides (Gr. καρυάτιδες). In Architecture, this term is used to signify the figures which are sometimes introduced to support a cornice instead of columns. According to the mythical account given by Vitruvius, they were so called to commemorate the disgrace of the people of Caryæ, a city in Arcadia, which was attacked and taken by the confederate Greeks for joining the Persians, the men being killed and the women led into captivity. The fig. No. 1 is that of a caryatid from the Pandroseum, at Athens; No. 2 is a CANEPHORA [which see]. When the figures introduced to support a cornice are male, they are said to be Persians; this is purely a modern name founded upon the tale related by Vitruvius, and adopted by the architects of the Renaissance.

1

2

Caryocar (Gr. κάρυον, *a hard-shelled fruit*). A genus of trees inhabiting the forests of tropical America, especially Guiana; one of them, found in woods near Mariquita, is said to attain the height of 240 feet. The Saouari (vulgarly called Suwarrow) or Butternuts of the shops, a delicious fruit, with a large

soft buttery kernel, are the seeds of *Caryocar nuciforme* and other species. Properly the name Saouari applies to *Caryocar butyrosum*.

Caryophyllaceæ (Caryophyllus, the Clove Carnation, a prominent plant of the order). An extensive natural order of Exogenous plants of the Silenal alliance, distinguished by their opposite leaves without stipules, symmetrical flowers, conspicuous corolla, and amphitropal ovules. One group, the *Alsineæ*, consists of rather weedy plants, as *Arenaria* and *Stellaria*; while another, the *Sileneæ*, consists of the more showy *Dianthus*, *Silene*, *Agrostemma*, *Lychnis*, &c. The species do not possess any very important properties.

Caryophyllaceous. A corolla whose petals have long claws dilating into a broad limb, as in the Clove Carnation (*Dianthus Caryophyllus*).

Caryophyllia. [MADREPORE.]

Caryophyllic Acid. *Eugenic acid.* A colourless oily liquid forming the oxidised portion of the essential oils of cloves, pimento and cinnamon leaf.

Caryophilline. A crystalline substance (called also *Clove camphor*) deposited by a strong alcoholic tincture of *Cloves*. In composition it resembles common camphor: $C_{10}\,H_8\,O$.

Caryophyllus (Gr. καρυόφυλλον, *the clove-tree*). The genus of *Myrtaceæ*, which yields the Cloves of commerce. These are produced by *C. aromaticus*, a tree of some twenty to thirty feet high, with large elliptic leaves and corymbs of purplish flowers having a long cylindrical calyx, four petals adhering by the points, and numerous stamens in four parcels. The cloves are the flower buds while yet unopened. They were formerly only grown in Amboyna, but are now cultivated in the West Indies and elsewhere.

Caryopsis (made up from Gr. κάρυον, *a nut*, and ὄψις, *appearance*). The technical name of the grain of corn. It is an indehiscent one-celled fruit, with a membranous pericarp adhering firmly to the seed.

Caryota (Gr. καρυῶτις). A genus of beautiful palms of lofty stature, wild in India and the Indian islands. *C. urens* grows to fifty or sixty feet in height, and has twice pinnated leaves, the leaflets of which are shaped somewhat like a scalene triangle with one margin deeply jagged. It yields amongst other useful products a large quantity of jaggery or palm sugar. Sago is also obtained from the pithy part of its trunk. A strong fibre called kittul is extracted from the leaf stalks.

Cascable. That part of a piece of ordnance which lies behind the base ring. [GUN.]

Cascalho. An indurated soil of Brazil forming the matrix of gold and of diamond in that country. It seems to consist of the fragments of those veins that have been by some means broken up, rolled by water, and buried among clays. The embedded stones are rough and angular, and thus the whole is a gravel formed on the spot and not exposed for any long period to the action of water. *Cascalho* differs from ordinary auriferous gravel, the latter being evidently waterworn and removed far from its source, whereas the former must be very near the parent rock judging from the condition of the stones.

The cascalho has not ceased to be important in reference to gold production in spite of the much larger supplies recently obtained from California, Australia, and other gold districts. It is still worked largely and to profit.

Some auriferous breccias in other countries have sometimes been called by this name, but without much real resemblance.

Cascarilla (Span. dim. of cascara, *bark*). The bark of the *Croton Eleutheria*, imported for medical use from Jamaica and the Bahamas Islands. It is bitter and aromatic, and when burnt it diffuses an odour much resembling that of musk.

Cascarilline. The bitter principle of Cascarilla bark. It occurs in acicular crystals.

Case (Lat. casus; from cado, *I fall*). In Grammar, that modification of a noun which designates the relation in which a substance is conceived to exist in regard to some other substance. This end is commonly attained in language by changes in the termination of nouns. In English there are but three cases: the nominative, the genitive or possessive, and the accusative or objective case; the last only in pronouns. All other varieties of relation are expressed by prepositions. [GRAMMAR.]

CASE (Fr. casse). In Printing, the receptacle for the types, from which the compositor gathers them separately, and arranges them in lines and pages. They are usually in pairs; one of which is styled the upper case, and is divided into ninety-eight boxes or recesses of equal size, in which are deposited the capitals, small capitals, accented letters, figures, &c.; the other is called the lower case, and is divided into fifty-three boxes or recesses of unequal size, containing the small letters, spaces, &c., the letters most in use having the largest boxes assigned to them. The cases are two feet nine inches long, one foot four inches and a half broad, and an inch in depth.

Case Hardening. The superficial conversion of iron into steel.

Case, Trespass on the. In Law, a form of action applying in cases of mediate or consequential injury. The distinctions between this and the common form of trespass for immediate injuries, formerly very difficult and refined, have been rendered unimportant by modern improvements. [PLEADING.]

Case-shot or **Canister-shot.** Consist of a number of iron balls placed in a tin cylinder with a wooden bottom of the size of the piece of ordnance it is intended for. They are used only at short ranges, not exceeding 300 yards.

Caseic Acid. A peculiar acid extracted from cheese.

Caseine. The chief nitrogenous constituent of milk. It forms the greater part of cheese. It differs from fibrine and albumen in being coagulated neither spontaneously nor by heat,

but by acids. Rennet, the substance produced by the slow decomposition of the rennet bag or fourth stomach of the calf, also causes the coagulation of casein, as seen in the *curding* of milk.

Casemate (Fr.). In Fortification, a bomb-proof arched chamber, usually constructed under the ramparts. It serves for a battery, and for cover for the men off duty, the sick and wounded, &c.

Casement. In Architecture, this word is applied to a vertical sash hung upon hinges. It is also used in the sense of the moulding called a SCOTIA [which see].

Caserns (Fr. caserne). Huts erected on the ramparts, or between the ramparts and the houses, of fortified towns, serving as temporary lodgings for the soldiers on duty.

Caseum (Lat.). The basis of cheese. The peculiar curd of milk.

Cash (from Fr. caisse, *a box*). In Commerce, the ready money, bills, drafts, bonds, and all immediately negotiable paper in an individual's possession.

Cashew Nut. The fruit of the West Indian *Anacardium occidentale*.

Casket. A small rope used to fasten the sail to the rope in furling. [GASKET.]

Caspian Sea. [ARALO-CASPIAN.]

Cassamunar. A root brought from the East Indies, and formerly used in medicine as a warm bitter.

Cassareep. The inspissated antiseptic juice of the Cassava, which forms the basis of the West Indian pepper-pot.

Cassation, Court of. The highest judicial institution in France; so termed from possessing the power to quash (casser) the decrees of inferior courts. It is a court of appeal in criminal as well as civil cases. The tribunal of cassation was first introduced, as a court wholly independent of the king and his council, in 1790. This court is under a president; but the minister of justice, as keeper of the seals (*garde des sceaux*), has the right of presiding in cases where it sits on appeal from the cours royales. The three sections are: 1. Des requêtes, which decides on the admissibility of petitions of appeal in civil cases; 2. De cassation civile; 3. De cassation criminelle. The decision of the court of cassation has the effect of sending back the case to the inferior courts. If, after a decision has been reversed, a second court decides the same case in the same way, and on appeal being entered again, the court of cassation repeats its reversal by all the three sections, such judgment is final. The inferior judges of the three sections of the court of cassation are styled counsellors.

Cassava. The purified starch obtained from the roots of the *Manihot utilissima*.

Cassell Yellow. A compound of oxide and chloride of lead: it is also known in commerce under the name of *patent yellow* and *Turner's yellow*.

Cassia (Gr. κασία). A genus of Leguminous plants of considerable importance from a medical point of view, inasmuch as it is the source of Senna leaves. Alexandrian senna is made up of *C. acutifolia* and *C. obovata*, East Indian or Tinnevelly senna of *C. elongata*, and Aleppo senna of *C. obovata*. They are annual and somewhat shrubby herbaceous plants, with compound pinnated leaves, and flowers having five unequal sepals, five yellow not papilionaceous petals, and ten stamens, of which three are long, four short, and three sterile or abortive. They differ in the form of their leaflets: those of *C. obovata* being obovate; those of *C. acutifolia* and *elongata*, lance-shaped. Other species, but probably of less importance than these, are grown. *C. fistula* is sometimes called CATHARTOCARPUS [which see].

CASSIA or CINNAMON. The bark of the *Laurus Cassia*; its flavour somewhat resembles that of cinnamon, and it yields an essential oil, which is pungent and stimulant.

Cassideous (Lat. cassis, *a helmet*). In Botany, when the upper petal of a flower is dilated into a broad helmet-shaped leaf, as in the genus *Aconitum*.

Cassididæ (Lat. cassis, *a helmet*). A family of Tetramerous Coleopterans, generally known by the name of tortoise-beetles, distinguished by having straight short filiform antennæ, inserted close together in the upper surface of the head, mouth situated on the under surface of the head, with strong and broad mandibles; legs short, with the tarsi flattened, the third joint deeply cleft, receiving between its lobes the terminal joint; margins of the thorax and elytra much dilated, so as to give the insects the appearance of small tortoises. The larva of the *Cassididæ* is remarkable for an apparatus, or anal fork, by which it collects and forms of its excrements a kind of parachute or defensive covering.

The genera of *Cassididæ* are, *Alurnus*, *Hispa*, *Chalepus*, *Imatidium*, and *Cassida*; the latter is the only indigenous genus, and of this the most common example is the *Cassida equestria* of Fabricius.

Cassinian Ovals. Such an oval may be defined as the locus of the vertex of a triangle of which the base and rectangle under the sides are given. Taking the base ($2a$) as axis and its middle point as pole, the equation is clearly

$$r^4 - 2a^2r^2 \cos 2\theta + a^2(a^2 - b^2) = 0,$$

where $a\,b$ is equal to the constant rectangle.

In rectangular coordinates the equation is

$$(x^2+y^2)^2 + 2a^2(x^2+y^2) - 4a^2x^2 + a^2(a^2-b^2) = 0,$$

whence it is concluded that the ovals in question are curves of the fourth order and eighth class. The circular points at infinity are double points, the tangents at which meet the curve in four consecutive points, that is to say each branch of the curve has also an inflexion at these points. The extremities of the base of the triangle are foci of the curve. As b increases from zero, the curve, starting from the initial state of two isolated points, becomes transformed into a pair of ovals around those points, until the value $b = a$ is reached, when the two ovals join and form the *lemniscata* of Bernoulli.

After this the curve consists of one continuous oval surrounding all the preceding ones.

Cassiopeia (Gr.). One of the constellations of the northern hemisphere.

Cassis (Lat.). A genus of Gastropodous Molluscs, separated by Lamarck from the Linnæan genus *Buccinum*, and including the species of which the shells are commonly called 'helmets.' The nacreous or inner layers of these shells are exquisitely sculptured by Italian artists in imitation of antique cameos: the different coloured layers of the shell resembling the onyx and other precious stones.

Cassiterite (Gr. κασσίτερος, *tin*). Native peroxide of tin; composed, when pure, of 21·62 per cent. of oxygen and 78·38 tin. It occurs massive (*Tin-stone*), disseminated, fibrous (*Wood-tin*), in rolled pieces and in grains as sand (*Stream-tin*), and crystallised in quadrangular prisms terminated by four-sided pyramids and in many complex forms: sometimes in twin crystals. The colour is of all shades between light brown and black, but it sometimes has a greenish tint, and is sometimes colourless, as at Mount's Bay in Cornwall, where transparent, white, glassy crystals of great beauty (*Tin-diamonds*) have been met with. The darker crystals are in general opaque, and the lighter ones translucent and semi-transparent. Lustre splendent.

The peroxide is the common ore of tin, and the only one from which the metal is obtained. It occurs in veins and large irregular masses, disseminated in granite, gneiss, clay-slate, mica-slate, and porphyry. The largest supplies are obtained from Cornwall, where mines have been worked for tin from a very remote antiquity. The principal Cornish mines are in the neighbourhood of St. Agnes, St. Ives, Gwennap, Helstone, and Penzance in the west, and near St. Austell in the east; small quantities are also procured near Tavistock. The other chief localities are the island of Banca, off the north-east coast of Sumatra; the peninsula of Malacca; Finland, Sweden, Greenland, France, Spain, Bohemia, Saxony, Chili, Peru, Mexico, California, and Australia under the form of black sand, in the alluvial gold washings.

Cassiterotantalite. A variety of Tantalite from Finbo and Broddbo in Sweden, containing a large amount of oxide of tin mechanically mixed with it.

Cassius, Purple of. So called from its inventor. A beautiful purple used in porcelain painting, and for staining glass. It is formed by immersing tin in a solution of gold. It is probably a mixture of oxide of tin and finely divided gold.

Cassowary (Casuarius, from the Malay word cassuwaris). A genus of Coursers or Struthious birds, inhabiting the islands in the Indian archipelago; the wings are shorter than in the ostrich, and are armed with strong spines, for the purpose of combat or defence. The head is surmounted by a bony protuberance covered with horn.

Cassythaceæ (Cassytha, the only genus). A most singular natural order of plants, having the fructification of the *Lauraceæ*, and the manner of growth and general appearance of a *Rhipsalis*, or rather a *Cuscuta*. They inhabit the tropical parts of the world, and are now regarded as an anomalous group of *Lauraceæ*.

Cast Iron. [Iron.]

Cast, Rough. [Rough Cast.]

Castanea (Lat.). A genus of trees or shrubs, related to the oak, and producing for fruit the seed-like nuts called Chestnuts in this country. The common Spanish Chestnuts, of which large quantities are annually imported from the south of Europe, are the fruit of *C. vesca*. A much smaller nut is obtained in North America from the *C. pumila*, or the Chinquapin Chestnut. The timber of the common Spanish chestnut is good and durable, more so than that of the oak, when the latter is young; but the notion that the ancient roofs and beams occasionally found in buildings of the Norman era, and which carpenters call chestnut, are the wood of this tree, appears to be erroneous. Such instances all belong to the kind of oak called *Quercus sessiliflora*. The genus *Castanea* differs from *Quercus*, among other things, in having the nuts enclosed in a spiny closed-up cup, instead of a shallow open one; but in the East Indies, where both oaks and chestnuts assume very remarkable forms, the two approach each other sometimes so nearly in this particular, that it is difficult to distinguish them.

Castanets (Span. castañeta, Fr. castagnettes). Small wooden or ivory musical instruments, played by being tied to the fingers, and thus rattled by dancers to the time of the music of the dance. They are chiefly used in Spain.

Caste (Port. casta). A term borrowed from the Portuguese settlers in India, which is used to denote the hereditary classes into which the population of Hindustan is divided, according to the religious law of Brahma. The origin of these classes is detailed in the sacred book which contains the ordinances of Menu. According to this authority, the Brahman, the Kshatriya, the Vaisya, and the Sudra sprang respectively from the mouth, the arm, the thigh, and the foot of Brahma. 1. The class of Brahmans, or priests, are far exalted above the rest in honour and privilege, and should be devoted entirely to prayer and meditation, or at least to the most exalted concerns of life. Many Brahmans, however, do in fact engage in secular pursuits, not only as ministers of sovereign princes (an office for which, according to the ordinances above cited, they are indeed peculiarly fitted), but also, in Guzerat and other parts of Western India, as merchants, or in the lower employment of messengers and porters; while many enter the British service as private soldiers. These, however, are Brahmans of the first and second classes (Brachmachari and Gribast'hal), youths or married men who as yet live in the world; from which the two higher classes, Vanaprastha and Sunnyassi, are wholly divorced. From the latter spring the various orders

of fanatics with which India swarms. 2. To the Kshatriya, or soldier caste, belong not only the high military classes, but in some parts of India whole tribes, as the Sikhs, &c. 3. The Vaisya, or commercial class (*wealth*). 4. The Sudra, or caste of tillers of the soil (*labour*). These are deeply degraded below not only the Brahmans, but the other two castes; and even the reading of the Vedas or sacred books is forbidden to them. Besides these four grand divisions, the Hindus have many subdivisions of caste, and no fewer than thirty-six are reckoned which are all inferior to the Sudra. These descend, according to the mythological history of the Hindus, from the 'Burren Sunker' or mixed class, proceeding from the confusion of castes which took place under the reign of a wicked and irreligious monarch. Finally, the Pariahs and some other races are considered as having no caste at all, and mere outcasts from humanity. Traces of the system of caste, which confines employments to hereditary classes, are to be found in the institutions of many countries, and in the history of many more. That the Egyptian nation was thus divided, is well known; and it is supposed that similar institutions prevailed in the ancient Assyrian empires. If Plato can be relied on as an authority, the Athenians in the first ages of their commonwealth were divided into five classes of the same description — priests, handicraftsmen, shepherds and hunters, ploughmen, soldiers. The Cretans, it is said, were divided, according to the laws of Minos, in the same manner as the Egyptians.

Castellated (Lat. castellum, *a fortress*). In Architectural works, the term castellated is applied to buildings finished in the style of a castle or of military architecture.

Castellite. The name given by Breithaupt to crystals of a clear yellow colour, which are found with brownish yellow Sphene, in phonolite, at Saalesel in Bohemia.

Castelnaudite. A variety of Xenotime found in imperfect crystals and irregular grains of a greyish white to a pale yellow colour, in the diamond-sands of Bahia in Brazil. It consists chiefly of hydrated phosphate of yttria.

Casting. A term used in Architecture to express the bending of the surfaces of a piece of wood from their natural state, caused either by the gravity of the material, or by its being subject to unequal temperature, or by the inequalities of texture of the material. It is more commonly called Warping.

Casting. In Foundry, the running of liquid metal into a mould prepared for that purpose. [Foundry.]

Casting. In Seamanship, is the act of allowing the ship's head, previously pointing to the wind, to fall off so as to bring the wind on the vessel's side.

Casting off Copy. In Printing, ascertaining accurately how many pages in print a given quantity of manuscript copy will make; or how many pages a given quantity of printed copy will make when the size of the book and the type are changed; also when a given quantity of manuscript copy is delivered, with directions that it is to make a certain number of pages in print, to determine the size of the page and the size of the type. This is usually done by composing a line or two of the copy, when, supposing a line and a half of it makes a line of print, it becomes a mere arithmetical question. Supposing there are 12,000 lines of copy, it will make 8,000 lines in print, which, at 24 lines to a page, will be 333 pages, and with the title, short pages &c. equal 14 sheets in 12mo.

Casting of Draperies. In Painting, the disposition of the folds of the garments wherewith the figures in a picture are clothed. Carlo Maratti thought that the disposition of drapery was a more difficult art than even that of drawing the human figure, and that a student might be more easily taught the latter than the former. Inferior painters enter into the minute discriminations of quality in drapery; but, as Sir Joshua Reynolds has well observed in his Fourth Discourse, with the historical painter 'the clothing is neither woollen nor linen, nor silk, satin, nor velvet; it is drapery; it is nothing more.' The figures of Raphael, in his painting, are generally draped; those of Michael Angelo commonly nude.

Castle (Lat. castellum). In Architecture, a building fortified for military defence, and also a house with towers, usually accompanied with walls and a moat, and having a donjon or keep in the centre. The principal castles in England at present are the Tower of London, Dover, Windsor, Norwich, &c.; but at one time those of Harwood, Spofford, Kenilworth, Warwick, Arundel, and others, might have vied with them in importance. The characteristics of a castle are its valla (embankments) and fossæ (ditches), from the former of which the walls arise usually crowned by battlements, and flanked by circular, or polygonal, bastions at the angles formed in the walls. These walls were pierced for gates with fixed or draw bridges and towers on each side; the gates, which were of considerable strength, were further guarded by descending gratings call *portcullises*; and all the apertures were made as small as they could be consistently with the requirements of internal lighting. The component parts of a castle were: 1. The foss, or moat, with its bridge; 2. The barbican, which was in advance of the castle, and was a raised mound or tower, the outer walls having terraces towards the castle, with bastions, as above mentioned; 3. The gatehouse, flanked with towers and crowned with projections called machicolations, through which heavy materials or molten lead were dropped on the assailants entering the gateway; 4. The outer ballium or area within the castle, which was separated from the inner ballium by an embattled wall with a gatehouse, and where the stables and other offices usually stood; 5. The inner ballium for the residence of the owner or the governor with his retinue; this had at one corner, or in

the centre, a donjon, or keep, which was the stronghold of the place, and usually contained the state apartment; 6. A well, and a chapel; the former usually, and the latter frequently, are found in ancient castles which are complete in their arrangements.

For further information on the subject, the reader is referred to King's *Mun. Antiq.* fol. 4 vols.; the *Archæologia*, in several places; Leland's *Collect.* vol. xi.; Woolnoth's *Ancient Castles of England and Wales*; and to Viollet le Duc, *Architecture Militaire du Moyen Age*.

Castor (Gr.). A remarkable double star in the constellation Gemini, called also α Geminorum. The two stars, which are easily separated by a moderately good telescope, rotate around their common centre of gravity, and, according to Sir J. Herschel, complete their rotation in a period of 253 years. (*Mem. Royal Astron. Soc.* vol. v.)

CASTOR. A peculiar concrete substance, contained in oval pouches situated near the anus of the *Castor Fiber* or *beaver*. There are four of these pouches; two contain a species of fat; while the two larger ones include in their membranous cells a viscid fetid substance, which is the *castor* of the Materia Medica. It is imported from Russia, Prussia, and Poland, and from Canada: the latter, known in trade under the name of *New England castor*, is very inferior. It is said to be an antispasmodic.

CASTOR. A silicate of alumina and lithia found in imperfect crystals in geodes embedded in the granite of Elba, with an allied mineral which has received the name of Pollux, and crystals of Felspar, Quartz, Beryl, Tourmaline, &c. It is colourless and transparent, and has a high glassy lustre.

CASTOR. The generic name of the beaver (*Castor Fiber*, Linn.).

Castor Oil. The expressed oil of the seed of the *Ricinus communis*, or *Palma Christi*. It is a mild aperient.

Castor and Pollux. The name given to an electrical meteor which sometimes appears at sea, attached to the extremities of the masts of ships under the form of balls of fire. When one light only is seen, it is called Helena. The meteor is generally supposed to indicate the cessation of a storm or a future calm; but Helena, or one ball only, to portend bad weather.

Castrametation (Lat. castrum, *a camp*, and metor, *I measure*). The art of laying out camps, whether the troops to occupy them are to be hutted, under canvas, or bivouacked. The situation for a camp should be healthy, not liable to be flooded, well provided with water, and should have good supplies of forage and wood close at hand. If troops are on active service it must be capable of defence, and should not be overlooked. [CAMP.]

Casuarinaceæ (Casuarina, one of the genera). A curious natural order of plants, inhabiting New Holland, some parts of India, and the South Sea Islands, with long slender creeping branches, resembling those of *Equisetum*, and bearing only scales in the place of leaves. The order is nearly allied to *Myricaceæ*, and belongs to the most imperfect forms of Exogenous vegetation, ranking in the Amental alliance, where they are known by their one-celled ovary and one or two ascending ovules, with a superior radicle. The *Casuarinas* are called Beefwood.

Casuist, Casuistry (from Lat. casus). In Theology, a casuist is a doctor charged with the decision of cases of conscience. The Jesuits were distinguished for the cultivation of this mixed subject of theology and ethics; which was admirably calculated to promote the policy of that order. The science of moral theology deals with the enunciation and exposition of principles; but casuistry, in the common acceptation of the term, confines itself to particular cases as they arise, and has led to narrow views and great perversions of truth and morality. The teaching of casuistry was common to Lutherans and Calvinists in the sixteenth century, as well as to Romanists; but it was by the Jesuits that it was chiefly cultivated, so that in common language Jesuitical and Casuistical have become almost equivalent terms of reproach. (Mayer's *Bibliotheca of Casuists.*)

Cat. A ship employed in the coal trade.

CAT. Tackle by which the anchor is raised to the cathead. (Falconer's *Dict.*)

CAT. [FELIS or FELINÆ.]

Cat Head. A Nautical term, signifying a strong inclined piece of timber projecting from either bow of a ship, to which the ring of the bower anchor is secured. The block or pulley hooked to the ring is called the *cat-block*, the rope the *cat-fall*.

Cat Silver. A name given to Mica by the old German miners.

Cat's-eye. A beautiful variety of translucent chalcedonic Quartz, of various shades of greenish grey or brownish red. The substance of the stone is penetrated by small parallel fibres of Asbestos, and when polished it displays a peculiar pearly opalescence, or floating internal light [CHATOYANT], much resembling the mutable reflections exhibited by the contracted pupil of the eye of a cat when held towards the light. It is chiefly brought to this country from Ceylon; but it also occurs in Scotland, and a pale-green variety is found in the Vale of Llanberis in Caernarvonshire, associated with Epidote. It is used in jewellery, and is cut *en cabochon*.

Cat's-tail Grass. A valuable meadow grass, usually forming part of all good lowland pastures. It is the *Phleum pratense*, a plant with a soft narrow cylindrical head, resembling that of the meadow Foxtail Grass.

Cat-harpings. Small ropes used to tighten the shrouds below the tops, and to draw them towards the mast that they may not interfere with the swing of the yards.

Cat-o'-nine-tails. A whip divided into nine strings of knots which forms a terrible instrument for the infliction of corporal punishment in the navy and army, and in certain cases in the civil prisons.

Catabaptists (a word formed on a false analogy from Gr. κατά, *against*, and βαπτίζω, *I baptise*). In Ecclesiastical History, a general term to designate all the sects which have denied the necessity of baptism generally, or have opposed infant baptism. [BAPTISTS; QUAKERS; SOCINIANS, &c.]

Catacaustics (Gr. κατά, and καίω, *I burn*). In Optics or Geometry, are the *caustic* curves formed by the reflection of the rays of light, and so called to distinguish them from the *diacaustic*, which are formed by refracted rays. [CAUSTIC.]

Catachresis (Gr. *a misuse*). In Rhetoric, a figure by which a word is used in a sense analogous to its own. [METAPHOR.]

Cataclesium (Gr. κατά, *against*, and κλείω, *I enclose*). A name applied sometimes to such a fruit as that of *Mirabilis*, which consists of a membranous indehiscent pericarp enclosed within a hard pericarp-like tube of the calyx.

Cataclysm (Gr. κατακλυσμός, *an inundation, a deluge*). Geologists apply the word to signify the various great inundations which they conceive to have occurred at different periods in the history of the globe.

Catacomb (a word of very doubtful origin; the Low Latin form is *catacumbæ*). In Architecture, the name given to passages excavated in the soil with recesses for graves, or for cells used as bone-houses. The hypogæa, crypta, and cœmeteria of the ancients were used for the same purpose. In some cities it would seem that the great excavations made for the catacombs were devoted to other purposes than the interment of the dead, as at Syracuse the same cavern served for a prison as well as for a cemetery; and at Rome it appears that the catacombs were resorted to for the purpose of worship. The most celebrated excavations for the purpose of cemeteries are those of Rome, Naples, Syracuse, &c.; and those formed by quarrying for the stone used in building the city of Paris.

Catacoustics or **Cataphonics** (Gr. κατά, and ἀκούω, *I hear*; φωνέω, *I speak*). The science of reflected sounds; or that part of acoustics which treats of the properties of echoes, or in general of sounds which do not come to the ear directly, but after having been reflected by some substance. [ECHO and SOUND.]

Catafalque (Fr.). In Architecture, a temporary structure of Carpentry decorated with painting or sculpture, representing a tomb or cenotaph, and used in funeral ceremonies.

Catagrapha (Gr.). [FORESHORTENING.]

Catalectic (Gr. καταληκτικός, *deficient*). In Greek and Latin poetry, a verse wanting one syllable of its proper length: *acatalectic*, a verse complete in length; *hypercatalectic*, having one syllable too many; *brachycatalectic*, wanting two syllables.

Catalecticant. A certain invariant which, together with the canonisant, presents itself in the problem of the reduction of a quantic to its canonical form. The vanishing of the catalecticant, in fact, indicates the possibility of expressing a binary quantic of an even degree ($2n$) in the form of a sum of half this number of $2n^{\text{th}}$ powers. For instance, the catalecticant of the binary quantic $(a, b, c, d, e \between x, y)^4$ is the determinant

$$\begin{vmatrix} a & b & c \\ b & c & d \\ c & d & e \end{vmatrix},$$

and if this vanishes identically the quantic in question will be expressible in the form $u^4 + v^4$, where u and v are linear functions of x and y. In this particular case the catalecticant is the cubinvariant of the quartic. [INVARIANT.] In general the catalecticant of the quantic

$$(a_0, a_1, \ldots a_{2n} \between x, y)^{2n}$$

is the symmetrical determinant of the $(n+1)^{\text{th}}$ order

$$\begin{vmatrix} a_0\ a_1 & \ldots\ldots & a_n \\ a_1\ a_2 & \ldots\ldots & a_{n+1} \\ & \ldots\ldots\ldots & \\ a_n\ a_{n+1} & \ldots & a_{2n} \end{vmatrix}$$

whose formation is very simple. Mr. Sylvester's papers in the *Philosophical Magazine*, 1851, and *Cambridge and Dublin Math. Journal*, vol. vi., will furnish the reader with further details on the subject.

Catalepsy (Gr. κατάληψις, *an attack*). A disease in which the functions of the organs of sense and motion are suspended, whilst the heart continues to pulsate. The patients are said to be in a *trance*; and in this state they remain sometimes for hours, or even days.

Catalogue Raisonné (Fr.). In Bibliography, a catalogue of books, classed under the heads of their several subjects, and with a general abstract of the contents of works where the title does not sufficiently indicate it; thus serving as a manual, to direct the reader to the sources of information on any particular topic. The want of alphabetical arrangement is supplied by an index at the end. The catalogue of the French *Bibliothèque Royale* (10 vols. fol. 1739—53) is said to be the best work of this description, as far as it extends. A very valuable one has been commenced, but as yet only partially executed, of the National Library at Paris. [BIBLIOGRAPHY.]

Catalysis (Gr. κατάλυσις, *a dissolving*). That process in which a substance excites by its mere presence (and without undergoing change itself) some chemical action in the substances with which it is in contact.

Catamaran. A sort of raft used chiefly by the Indians on the Coromandel coast for the purposes of fishing. It is composed of three pieces of wood lashed together, the middle piece being longer and broader than the others: and it is almost the only kind of boat that can live in the surf that prevails on that coast. The name Catamaran was also given to the floating batteries with which the French at the commencement of the present century meditated the invasion of England.

Catamenia (Gr.). The monthly uterine evacuation.

Catapetalous (Gr. *κατά, against*; *πέταλον, a leaf*). When the petals of a flower are held together by stamens which grow to their bases, as in the Mallow.

Cataphracted (Gr. *κατάφρακτος*). Covered with a hard callous skin, or with horny or bony plates or scales closely joined together. Among the ancients, cavalry equipped with complete defensive armour were termed *equites cataphracti*.

Catapleite. A silicious mineral containing Zirconia of a pale yellowish brown colour, occurring in imperfect hexagonal crystals which are opaque, and nearly dull, in the island of Lamö, near Brevig in Norway.

Catapult (Gr. *καταπέλτης*). A Military engine used by the ancients for throwing stones, long darts, or javelins. The catapult is often confounded with the balista; but the latter engine seems to have been chiefly used for the purpose of propelling stones, while the former more frequently was employed with other missiles. Their size and construction were various, but the principle of action was the same in all; namely, the elastic force with which twisted rope uncoils itself.

Cataract (Gr. *καταῤῥάκτης*). An opacity of the crystalline lens of the eye, producing confused or indistinct vision, or total blindness, according to the less or greater extent of the thickening: it is sometimes rapid, and often very slow in its progress. It is distinguished from *gutta serena* by the visible opacity of the lens, and by the iris contracting upon exposure of the eye to light. This disease is curable either by depressing or extracting the lens, operations which are performed with wonderful dexterity by some modern oculists.

Catarrh (Gr. *καταῤῥέω, I flow down*). The complaint commonly called a *cold in the head*, generally attended by running from the eyes and nose, sneezing, hoarseness, and commonly ending in cough. It is produced by sudden changes of air or temperature, and by exposure to draughts of air. In its usual form domestic remedies relieve it—diluents, mild aperients, and abstinence from wine and animal food; but when attended by fever, headache, tightness about the forehead, and difficult breathing, it often requires more serious attention, and if neglected may lead to much mischief.

Catarrhines, Catarrhina (Gr. *κατάῤῥις, with a curved nose*). A tribe of Quadrumanes, including those which have the nostrils approximated, and the intervening septum narrow; as in the apes of the Old World.

Catastrophe (Gr. from *καταστρέφω, I overturn*). In modern Literary language, the final event of a drama or romance, to which the other events are subsidiary. The *περιπέτεια*, or revolution, indicated by Aristotle as one of the parts of the drama, was a change in the fortunes of the principal personages of the play: as the fall of Œdipus from sovereignty into extreme misery and banishment, in the *Œdipus Tyrannus*. Some such change is generally involved in the idea of a catastrophe: thus, marriage is the ordinary catastrophe of a comedy or a novel, as some disastrous change is that of a tragedy.

Catch-drains. Open drains across a declivity to intercept surface water. The term is sometimes also applied to under-drains across a declivity.

Catchword or **Direction-word.** In Printing, the first word of a page printed at the bottom right-hand corner of the preceding, to assist the reader. The first edition of Tacitus, printed at Venice by Johannes de Spira about 1469, is the earliest book in which catchwords are found.

Catchwork-meadows. Grass lands with a very regular sloping surface, subjected to irrigation, the water as it descends the declivities being intercepted by catch-drains.

Catechism (Gr. *κατηχέω, I instruct by word of mouth*). A form of instruction by question and answer, appropriated by general usage to instruction in religious subjects, and more especially to the set forms which most churches have authorised for the instruction of children in the elements of religion. The English church catechism is intended to be an exposition of the vow made at baptism, and till the time of James I. consisted only of the repetition of the baptismal vow, the creed, and the Lord's Prayer. The latter portion, explaining the nature of the sacraments, was added after the conference at Hampton Court. The catechism of the council of Trent, or *Catechismus ad Parochos*, was set forth by the Roman Catholic divines for the use and direction of the clergy, and contains an ample account of the whole sum of the Romish doctrines. It was approved by Pius V., and published in 1566. (Bingham's *Antiquities*, b. x. ch. i. ii.)

Catechu (a Japanese word, signifying the juice of a tree). The extract of the *Acacia Catechu*, an astringent substance, consisting of tan and extractive matter, imported chiefly from Bengal and Bombay. Also the inspissated juice of the palm, *Areca Catechu*. Its principal use is in medicine.

Catechuic Acid. A substance in the form of white silky filaments contained in *Catechu*. Its formula is $C_{14}H_6O_6$. It has also been termed *Catechine* and *Tanningenic acid*.

Catechumen (Gr. *κατηχούμενος*). He who learns the elements of any science: one who is undergoing a course of religious instruction with a view to his admission into the church. The Christian society in the early ages was divided into two classes, Fideles and Catechumeni: the former being those who had been admitted by baptism into the entire privileges of the church, the latter such as were preparing for that admission.

Categorematic (Gr. *κατηγόρημα, a predicate*). In Logic, when a word is capable of being employed by itself as a *term*, or predicate of a proposition.

Categorical Proposition (Gr. *κατηγορέω, I declare something of another*). In Logic, a proposition which affirms or denies, absolutely

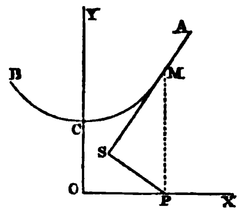
and without any condition, that the subject does or does not agree with the predicate. [PROPOSITION.] Categorical propositions are said to be pure (those which simply assert one thing of another), and modal (those which assert one thing of another under a certain mode or form). But this is a distinction arising out of the poverty of language only, and no essential difference between the two classes; e. g. 'the king reigns' is a pure categorical proposition; 'the king reigns justly' is said to be modal. But it is evident that if our language had a single word to express the whole idea (to reign justly), the latter would be called pure likewise. All cases of modal categoricals may probably be resolved into similar instances of the deficiency of words to express complicated notions.

Category (Gr. κατηγορία). In Logic and Metaphysics, a Greek word, signifying originally that which may be said or predicated of a thing; a general term in reference to a less general one which is included under it. By Aristotle, from whom the word, and its corresponding Latin term *predicate*, was borrowed by the schoolmen, it was applied to denote the *most general* of the attributes that may be assigned to a subject. Of these he attempted an enumeration, under the names of substance, quantity, quality, relation, place, time, condition, state or habitude, action, and passion. The word has been revived in modern times by Kant, to express the most general of the modes in which a thing can be raised from an object of sense to an object of intellect; or, in other words, the forms or conditions which must pre-exist in the understanding, in order that an act of intelligence may take place. For an account of these, see KANTIAN PHILOSOPHY. The difference between the categories of Kant and those of Aristotle is this, that the latter are mere generalisations from experience, which may consequently be multiplied indefinitely; whereas the former result from a professedly exhaustive analysis of the human understanding as it is in itself, or formally, that is, apart from all consideration of its object-matter.

Catenarian (Lat. catenarius, *belonging to a chain*). In Engineering, this term is applied to that form of arch which resembles the curvature a chain would assume if hung between the points of suspension, and reversed.

Catenary. The curve into which a chord or flexible chain of uniform density and thickness forms itself when suspended or allowed to hang freely from two fixed points, A, B. This curve was first noticed by Galileo, who proposed it as the proper figure for an arch of equilibrium; but he imagined it to be the same as the parabola. Its true nature was first demonstrated by James Bernoulli, and its various properties soon after pointed out by John Bernoulli, Huygens, and Leibnitz. It is interesting on account of the light it throws on the theory of arches, and also by reason of its application to the construction of suspension bridges.

The mechanical conditions of equilibrium, when expressed mathematically, lead to the differential equation $s = h\frac{dy}{dx}$; where x (horizontal) and y (vertical) denote the coordinates of any point M on the curve, and s the arc CM measured from the lowest point C, whose coordinates are o and h respectively. The mechanical definition of h is important; the weight of this length of string is precisely equal to the tension of the cord at the point C, and it can



moreover be easily shown that the tension at any other point M of the catenary is similarly measured by the corresponding ordinate MP; so that, O being the origin of the coordinate axes, and the points C and M being fixed, if portions of the string equal to MP and CO were cut off from the arcs MA and CB and allowed to hang freely from M and C, the equilibrium of CM would not be disturbed. The integration of the above differential equation leads to the relation $y^2 = s^2 + h^2$, and thence to the equation

$$y = \frac{h}{2}\left(e^{\frac{x}{h}} + e^{-\frac{x}{h}}\right)$$

of the curve; e being the base 2·7182818 of the natural system of logarithms.

The first two of the preceding equations lead to other interesting constructions. Let MSP be a right-angled triangle having the ordinate $y = \mathrm{MP}$ for hypothenuse and $\mathrm{PS} = h = \mathrm{OC}$ for one of its sides, the other side MS will obviously touch the curve at M, and be equal in length to the arc MC. The locus of S, therefore, will be the involute of the catenary, a curve known as the *Tractrix*, and belonging to the family of equi-tangential curves; the portion PS intercepted upon any tangent by the point of contact and a fixed line OX being constant. [TRACTRIX.]

For further information on the subject, see Poisson's *Mechanics*; Gregory's *Examples*; Wallace, *Edinburgh Transactions*, vol. xiv.; Whewell's *Analytical Statics*; Ware's *Tracts on Vaults and Bridges*, London 1822, &c.

Catenulate (Lat. catena, *a chain*). When a surface presents a series of elevated ridges or oblong tubercles resembling a chain.

Caterpillar. The name of the larvæ of Lepidopterous insects.

Catha (Arab. khât). A genus of *Celastraceæ* consisting of African shrubs, with spiny branches, simple leaves, and axillary small branching heads of flowers, distinguished from those of *Celastrus* by their five stalkless petals.

The leaves of *C. edulis*, the Khât or Cafta, are used by the Arabs in the preparation of a beverage possessing properties analogous to those of tea and coffee. The use of khât in Arabia is said to be of great antiquity, having preceded that of coffee. The twigs with leaves attached are the parts used. The effects of the decoction are similar to those of strong green tea.

Cathari (Gr. καθαρός, *pure*). An Oriental sect of Christians. [PAULICIANS.]

Cathartic (Gr. καθαρτικός, from καθαίρω, *I purge*). That which increases the action of the bowels. The term is commonly applied to medicines which do this with some degree of violence: among the milder cathartics, jalap, senna, calomel, and saline purges are the most used; those which are *drastic* are croton oil and elaterium.

Cathartine. The active or purgative principle of senna.

Cathartocarpus. A name sometimes applied to certain species of *Cassia* which have long black woody cylindrical pods one to two feet long, containing many seeds embedded in a mild laxative pulp. *C. fistula*, the Pudding Pipe-tree, a very handsome Indian tree, with the foliage of the ash and the inflorescence of laburnum, is the best known.

Cathedra (Gr. *a seat*). In mediæval Latin, the 'chair' or seat of a bishop.

Cathedral. The principal church of a diocese, in which is the cathedra or throne of the bishop. The choir of the cathedral church was made in early times to terminate in a semicircular or polygonal apsis; and in the recess thus formed were placed the throne of the bishop in the centre, and seats of an inferior class for presbyters. In modern cathedrals the bishop's throne is in the choir, and generally on the south side. (Bingham, viii. 6. 10.) [APSE; ABSIS.]

Catheta and Cathetus (Gr. καθέτη, κάθετος). In Architecture, a vertical line falling from the extremity of the underside of the cymatium of the Ionic capital through the centre of the volute.

Catheter (Gr.). A tube which may be introduced by the urethra into the bladder for the purpose of drawing off the urine.

Cathode (Gr. κάθοδος, *a descent*). A term applied by Faraday to the negative pole, or electrode, in the voltaic circuit, the elements there eliminated being called *cations*.

Catholic (Gr. καθολικός, *universal*). A word which occurs in the New Testament in the titles of certain of the Epistles—those of James, Peter, and John—signifying that they are addressed to the whole or universal body of Christians, and not to a particular section of them. It was used in primitive times to mark the difference between the Christian church, open to all nations through baptism, and the Jewish, which was ordinarily confined to a single people. '*A* catholic church means a branch of this one great society, as the church of England is said to be *a* catholic church: *the* catholic church includes all the churches in the world under their legitimate bishops.' (Hook's *Church Dictionary.*) [CHURCH; HERETIC; ROMAN CATHOLIC.]

Catholicon (Gr.). In old Pharmacy, a universal medicine.

Cation. [CATHODE.]

Catjang. The Malabar name of *Cajanus indicus*, a kind of pulse much used in the tropics.

Catkin (Dutch, *kattekens*). In Botany, the name applied to the inflorescence of the poplar, willow, and similar trees. A catkin or ament is a close spike, composed of scales overlapping each other; it falls off the parent plant as soon as its office of flowering or fruiting is accomplished.

Catling. A term applied by surgeons to a knife used in amputations.

Catlinite. A reddish variety of clay-stone from the Côteau des Prairies, west of the Mississippi. It is carved into tobacco-pipes by the Indians, and named after Catlin the American traveller.

Catoptrics (Gr. κατοπτρικός, *reflexive*). Is that part of the science of Optics which treats of the laws of reflected light and the phenomena of vision produced by reflection. [MIRROR; OPTICS; REFLECTION.]

The principal authors who have treated of Catoptrics are Euclid; Alhazen and Vitellion, in the eleventh and twelfth centuries; James Gregory in his *Optica Promota*; Barrow, Smith, Tacquet, and most modern writers on the subject of Light or Optics.

Catoptromancy. Divination by means of a mirror.

Catsup. A sauce prepared from mushrooms, walnuts, and other vegetable productions. It is often written ketchup, and is said to come from the Eastern kitjap.

Cattemundoo. A gum-elastic obtained from *Euphorbia antiquorum*.

Cattle (Low Lat. catalla, *chattels*). Domesticated animals of the cow kind, which are found accompanying man in every civilised country, and in every climate. The native country of the type of British cattle is supposed by some to be Asia; but in this case, as in all others where an animal or a plant has been long in a state of domestication, the origin of the species is involved in obscurity. When the tame cattle of any country are allowed to run wild and breed in that country, uncontrolled by man, the habits which belong to the animal in its savage state become, in the course of three or four generations, modified according to the natural supplies of food and the character of the climate. Hence, though cattle are not indigenous to Britain, South America, or the Sandwich Islands, we have in the former country a breed of wild cattle in one or two gentlemen's parks, as at Chillingham in Northumberland, which are quite different from the wild cattle of the fertile soils of South America, as these again are different from the wild cattle of the Sandwich Islands, though all undoubtedly the descendants of tame animals. Those

in the Sandwich Islands, in particular, are known to be the offspring of the tame cattle that were left there by Vancouver, and which can now be only caught alive by entrapping them in disguised pits; into one of which the unfortunate botanist Douglas fell, and was gored to death by a bull which happened to be in it at the time.

The domestic cattle of Britain may be divided into two principal races: those of large size adapted for the plains, and those of smaller size adapted for the mountains. Of each of these classes there are several breeds; such as the Highland and the Welsh cattle, among the latter; and the Lancashire, the Yorkshire, and the Herefordshire cattle, among the former. There is also an intermediate breed, adapted for moderately hilly countries; such as the Galloway and Fife breeds in Scotland, and the Alderney and Guernsey cattle in England. The shorthorn, Hereford, and Devon are the three leading English meat-producing breeds. The dairy breeds are the shorthorn, longhorn, Ayrshire, Alderney, and Suffolk. The best beef brought to the London market is that of cattle of the Highland breed fed in English pastures, or on turnips. The best milk cow for general purposes is the Ayrshire; the best for cream and butter, the Alderney; and the best for immense quantities of milk, the Lancashire and shorthorns. Hence the latter breeds are generally employed in public dairies, the Ayrshire and Suffolk by farmers and cottagers, and the Alderney by the higher classes.

Catulus (Lat. *the young of anything*). The old botanical name of the catkin of a plant.

Caucasus. This lofty range, almost connecting the mountains of Persia with the Carpathians, and separating the great Aralo-Caspian region from the Black Sea, extends for about 700 miles in a continuous chain, and has several offshoots, or transverse ridges, penetrating both towards Russia and into Asiatic Turkey. The chief elevations are very lofty, the highest being estimated at 18,500 feet, and another peak at no great distance 16,500 feet. These two culminating points occupy nearly the central portion of the main chain, which is rather narrow. The limit of snow is 11,000 feet, and the whole of the central part of the mountain group is full of glaciers.

The Caucasus connects on the east with the lofty table-lands of Asia and Asia Minor, and thus with the serrated snowy range of the Taurus and Armenia, of which Mount Ararat (17,200 feet) is the culminating point. All the mountains of the Caucasus are split and rent by deep gorges, and the valleys afford some of the most remarkable and picturesque mountain scenery that has ever been described. Mount Ararat is a volcanic cone.

Cauda (Lat.). That portion of an animal which is supported by vertebræ behind the sacrum; these vertebræ, in fishes, bearing inferior spinous processes. In Entomology, it signifies that part of the abdomen which becomes suddenly slender, and terminates in a long jointed tail, as in the scorpion.

Cauda Equina (Lat.). In Anatomy, the roots of the terminal spinal nerves which are contained in the neural canal of the vertebræ, and surround the 'filum terminale' of the myelon.

Caudate (Lat. cauda, *a tail*). In Anatomy, when the apex of a pyramidal part or organ is prolonged into a long slender point: certain microscopic bodies found in ganglia are termed especially 'caudate' nerve-corpuscles. In Zoology, an animal provided with a tail.

CAUDATE. In Botany, when the apex of any organ in a plant is extended into a long slender point; this is not of rare occurrence, and is especially common in Araceous and Aristolochiaceous plants.

Caudex (Lat. *a trunk*). The Linnæan name of what is now more generally called the axis of vegetation; the woody centre round which the leafy and leaf-like organs are arranged. The *caudex ascendens* was the stem, the *caudex descendens* the root of a plant.

Caudicula (a diminutive formed from Lat. caudex). A thin, elastic, semi-transparent process of the pollen masses of Orchidaceous plants, by means of which the pollen is brought in contact with the stigma or stigmatic gland.

Cauk. [CAWK.]

Caul. The trivial appellation of the *amnion* when it comes away in childbirth. It is regarded by the superstitious as a charm against shipwreck.

Cauliculus (Lat. dim. of caulis, *a stem*). In Architecture, the small stalks under the volutes of the Corinthian capital, which they seem to support.

CAULICULUS. In Botany, the slender part which connects the cotyledon of a seed with the radicle. It is considered an extension of the stem. Its office is to lengthen rapidly when germination takes place, and thus to bring the true radicle into contact with the earth upon which it has to feed.

Cauliflower (Fr. chou-fleur). One of the garden varieties of *Brassica oleracea*, in which the inflorescence while young is condensed into a depressed fleshy esculent head.

Cauline (Lat. caulis, *a stem*). In Botany, anything that grows to, or springs from, the stem of a plant. Thus cauline leaves are those which grow upon the stem; cauline prickles such as are borne by the same part, and so on.

Caulk or **Calk.** To stuff the seams or openings between the planks of a ship with oakum, which is rope untwisted into its original state of fibre. The oakum is forced in by a caulking chisel and mallet. It has been found necessary, when a ship has worked the oakum out of the seams, to fill them with rope. In addition to preventing leakage, caulking affords fixedness to the whole frame, and is therefore a great support. The quantity of oakum used in a large ship is very great:

in a first-rate it is nearly thirty tons, or upwards of four cables.

When the seams are caulked, melted pitch is poured on the seams of the decks out of a pitch ladle; in other places it is laid on with a pitch mop: this is called *paying* the seams.

Caulocarpous (Gr. καυλός, *the stem of a plant*, and καρπός, *fruit*). A name applied by De Candolle to plants which, like trees and shrubs, annually produce flowers and fruit on their branches without perishing.

Causalty. A miner's term for the light parts of ores which are carried away by washing.

Cause (Lat. causa). Four kinds of causes have been distinguished by logicians: *the material, the efficient, the formal,* and *the final*. The *material* cause of a thing is that out of which that thing is made; in other words, that which is the ground of the possibility of a thing's coming into existence: e. g. the marble out of which a statue is made. The *efficient* cause is that in which resides the moving power requisite in order to render the possible existence actual; as the sculptor. The *formal* cause is that which must supervene to the matter, in order to give the thing its precise individual existence as that thing and no other; as the shape which the sculptor communicates to the marble. This distinction is derived originally from Aristotle, with whom, however, it is rather a metaphysical than a logical determination. The *final* cause of the thing is that very thing in its completeness; as the statue when made. [Aristotelian Philosophy.]

In popular language, however, the *final* cause is synonymous with the purpose to which any object is supposed to contribute, though that purpose be wholly external to the thing caused.

Causeway (catachrestic for *causey*, Fr. chaussée, *a paved road*). A carriage road supported at a slight elevation above the surface of any marshlands, or water, which it may be found advisable to traverse; it differs from a viaduct, which is supported by piers and arches, whilst in a causeway the road is carried by an embankment, or by a low retaining wall.

Caustic (Gr. καυστικός, from καίω, *I burn*). When rays of light issuing from a luminous point are incident upon a surface separating two media, reflection and refraction take place according to well-known laws, viz. 1. The plane containing the incident and reflected or refracted ray contains the normal of the refracting surface at the point of incidence. 2. The angles of incidence and reflection are equal. 3. The sines of the angles of incidence and refraction have a constant ratio. Now the reflected as well as the refracted rays will by their mutual intersections give rise to a series of points, at which the intensity of light and heat will be in excess. The surface formed by such a series of points, that is to say, the envelope of the reflected or refracted rays, is called a *caustic* surface; the first a *caustic by reflection* or *catacaustic*, the other a *caustic by refraction* or *diacaustic*. The bright lines seen on a table upon which stand a bottle of water and a candle are familiar examples of the two kinds of caustics, or rather of the curves in which the caustic surfaces are intersected by the plane of the table. In the construction of reflectors, lenses, &c. the consideration of caustics is of manifest importance. The caustic by reflection from a paraboloid of revolution reduces itself to a point when the incident rays are parallel to the axis, hence the importance of parabolic reflectors. In the case of reflection from a sphere this property is lost, the caustic surface does not reduce to a point, and hence the pheromenon of spherical aberration.

The determination of caustic surfaces and caustic curves (which have an analogous definition, the reflecting curve and luminous point being in the same plane) is, however, a purely geometrical problem, and as such appears to have been first investigated by the German mathematician Tschirnhausen, who communicated his results to the Academy of Paris in 1682. As included in the more general theory of envelopes, the subject has been since much developed. (J. Bernoulli, *Opera Omnia*, vol. iii.; L'Hôpital, *Analyse des Infiniment Petits*; St. Laurent, *Gergonne's Annales de Mathématique*, vol. xvii.; Quetelet, *Mémoires de l'Académie de Bruxelles*; Malus, *Théorie de la Double Réfraction*, Paris 1810; Sir W. Hamilton, *Transactions of Royal Irish Academy*; Sir J. Herschell 'On Light,' *Encyclopædia Metropolitana*; Cayley, Holditch, and others, *Cambridge and Dublin Mathematical Journal* and *Quarterly Journal of Mathematics*; Dr. Salmon, *Higher Plane Curves*.

The following are a few of the more remarkable geometrical properties of caustics. If a curve equal and similar to the reflecting curve be allowed to roll upon the latter, so that homologous points may coincide with the point of contact, the point which, with respect to the rolling curve, is homologous to the luminous point, will describe a curve whose evolute is the caustic. In other words the caustic is the evolute of the *double pedal* of the reflecting curve with respect to the luminous point. [Pedal.] Thus the caustic by reflection from a circle is in general the evolute of an epitrochoid. This epitrochoid, however, the circles being equal, is well known to be a *Limaçon*, a curve of the fourth order belonging to the family of Cartesian ovals. Its evolute, the caustic, is a curve of the sixth order, whose equation was given by St. Laurent (see above). When the incident rays are parallel, the caustic is itself an epicycloid, and a cardioid, when the rays proceed from a point on the reflecting circumference.

The caustic by refraction may also be regarded as an evolute, the corresponding involute being the envelope of a series of circles having their centres on the refracting curve, and their radii proportional to the distances of these centres from the luminous point. This genera-

tion of a diacaustic, although apparently more complicated than the original one, is in practice often more convenient. Thus the caustic by refraction at a right line is the evolute of an ellipse whose foci are the luminous point and its *image* by reflection. The caustic by refraction at a circle is the evolute of a Cartesian oval, one of whose foci is the luminous point, and whose axis is the line joining this point and the centre of the refracting circle.

Another property common to all caustic curves, and which at an early period served to invest them with great interest, is that they are always rectifiable when the primitive curves are algebraic; in other words, a right line can always be found of the same length as any given arc of a caustic. When the rays, after suffering a single refraction or reflection, meet the same or another surface a second time, a *second* caustic is produced, and in a similar manner a whole series of related caustics may arise.

Caustic, Lunar. Fused nitrate of silver.

Caustics. Substances which corrode and destroy the texture of the skin and of organised bodies.

Cautery (Gr. καυτήρ, *a burner*). The ancients divided cauteries into *actual* and *potential*. The former term is applied to red-hot iron; the latter to pure potash.

Cautionary. In Scottish Law, is the obligation by which a party becomes surety for another; answering to the English term guarantee. It is defined by Stair, 'the promise or contract of a man not for himself but another.' The guarantor is termed 'cautioner.'

Cavædium (Lat.). In ancient Architecture, this word was applied to an open quadrangle, or court, within a house. The cavædia described by Vitruvius are of five species: Tuscanicum, Corinthium, Tetrastylon (with four columns); Displuviatum (uncovered); and Testudinatum (vaulted). Some writers make the cavædium the same as the atrium and the vestibulum; but it appears to have been in fact very different from either of those apartments.

Cavalier (Fr. from Latin caballus, *a pack-horse*; Span. caballero). This term was used originally in a general sense for a horse soldier; but it has acquired historical importance from its having been applied to the adherents of Charles I. in contradistinction to the ROUNDHEADS [which see], the supporters of the parliament.

CAVALIER. In Fortification, a sort of interior bastion, several feet more elevated than the principal bastion of the fortress in which it is formed. The use of the cavalier is twofold: it serves either to defilade the works from the fire of an enemy on an adjacent height, or to command the trenches of the besiegers. Cavaliers are sometimes constructed in the gorges, or on the middle of the curtain, and their form is the semicircular; but when they are within the bastion they are now built with straight faces and flanks parallel to those of the work in which they are placed. French cavaliers are works raised by the besiegers on the glacis of a fortress, for the purpose of enabling them to direct a fire of musketry into the covered way.

Cavalry (Fr. cavalerie). A body of soldiers furnished with horses for war. This arm can boast of high antiquity, and is so peculiarly useful and necessary for a great variety of operations, that it has in all ages been held by the greatest generals in high estimation. The efficacy of cavalry arises principally from its adaptation to speedy movements, thus enabling a commander to avail himself immediately of a decisive moment when the enemy exposes a weak point, or when disorder appears in his ranks, for completing his defeat by disconcerting him by a sudden attack. It is singularly useful in protecting the wings and centre of an army, for furnishing detachments, for escorts, for forming blockades, for intercepting the supplies of the enemy, for foraging, for procuring intelligence, for covering a retreat, &c. The successful services which troops of this description have performed, and the number of decisive advantages which have been obtained by means of them in the most important battles of which history ancient and modern furnishes the details, prove incontestably the utility of this arm. The use of cavalry, however, is necessarily limited by the nature of the ground. Open and level countries are favourable to its operations; in forests, in mountainous districts, on a marshy soil, &c. it is but of little avail. Among the Greeks and Romans, the cavalry was regarded as the most respectable class of troops. In the middle ages a similar feeling seems to have prevailed; for, in the early French monarchy, and in the Anglo-Saxon kingdoms of Britain, the men of wealth and noble birth distinguished themselves in the field from those of inferior rank by being well armed and mounted on horses; and from the mode of warfare then practised, as well as from the peculiarities adopted in the organisation of troops, cavalry constituted almost the only efficient arm of battle down to the introduction of standing armies; and only where they could not take their horses, the men-at-arms used to dismount and fight on foot.

In France especially so completely was the foot soldier looked down upon, that at Creçy, Philip of Valois called on his cavalry to cut to pieces his own crossbowmen, or 'rabble' as he called them, because they were in the way.

The use of the long bow by the English archers, who defended themselves from the attack of cavalry by planting stakes before them in the ground, first showed the inefficiency of these armour-clad mounted men; and later the invention of gunpowder, and the subsequent employment of artillery in the field, deprived the heavy-armed cavalry of those times of all the advantages it possessed over the infantry, and rendered its movements awkward and inefficient. It was reserved, however, for Gustavus Adolphus to show the real utility of this arm by discovering the services on which it

should properly be employed, and by stripping it of all unnecessary encumbrances to supersede by *rapidity of motion* the value it formerly possessed in *weight*. Since that time cavalry has often turned the scale of fortune in war: the battle of Rossbach, for instance, in 1757, one of the most brilliant victories either of ancient or modern times, was entirely decided by this arm.

Modern cavalry consists of two grand classes—*heavy* and *light* horse; which are again susceptible of further subdivisions, according to the purposes to which they are subservient. The British cavalry consists of two regiments of life guards, the royal regiment of horse guards, seven regiments of dragoon guards, and twenty-one regiments, of which three are dragoons, thirteen hussars, and five lancers. (For the history, use, accoutrements, and arms of these different branches, see the separate articles.) A regiment of cavalry is divided into four squadrons, and each of these into two troops. A troop consists of sixty-eight men; and to each troop there is attached a captain, a lieutenant, and a cornet.

Cavatina (Ital.). In Music, a term now usually applied to a vocal piece, for a single voice, extracted from an opera.

Cavea (Lat. *a hollow place*). This term was applied by the Romans to the interior of an amphitheatre. (Ammianus Marcellinus, lib. xxiv. c. i.)

Caveat (Lat.). In Law, a notice or caution given by a party interested to a judge or other officer, in order to stay proceedings by him; as, in the spiritual courts, a caveat is put in to stop the granting of probate or administration.

Cavendish Experiment. An important mechanical experiment for the purpose of ascertaining the mean density of the earth; the method employed being a comparison of the force of terrestrial attraction with that of the attraction of leaden masses of known magnitude and density, determined by means of the balance of torsion.

The idea of rendering sensible and measuring the attractive force exerted by a dense body upon another body in its immediate vicinity by means of the torsion balance, appears to have been suggested by the Rev. John Michell; but the experiment was first actually made by the celebrated Henry Cavendish, whose report is published in the *Philosophical Transactions* for 1798. It was subsequently repeated by Reich, Professor of Physics at Freiberg, in Saxony, who published his results in 1838; and again by the late Francis Baily, with far greater precision, and by a far more varied and extensive series of observations, the details of which are given in a paper of great value published in the *Memoirs of the Royal Astronomical Society*, vol. xiv. 1843.

In the mode of proceeding adopted by Cavendish, and followed by Baily, the data for determining the earth's mean density were obtained in the following manner: A slender deal rod of six feet in length, having a leaden ball of about two inches in diameter attached to each of its ends, is suspended horizontally from a beam by a fine metallic wire, about forty inches in length. This forms the torsion balance. Immediately under the balance is placed a strong horizontal plank about eight feet in length, supported by and turning upon an axle, the central line of which is in the same vertical with the suspension wire. On this plank, near its extremities, are placed two equal spheres of lead (twelve inches in diameter, and each weighing about 380 lbs.), cast with great care, in order that the density may be uniform throughout the mass, and accurately turned. The apparatus is so arranged that the centres of the two balls at the extremities of the arm of the torsion balance, and the centres of the two leaden spheres, or *masses*, are in the same horizontal plane, and equally distant from the vertical axis of motion. Suppose now the torsion balance to be at rest in a certain direction, and the plank which supports the masses to be at right angles to the direction of the balance; in this position the attraction of the two masses will have no tendency to give motion to the balance. But let the beam be turned round till the two masses approach near to the balls, then the attraction of each mass, acting most powerfully on the nearest ball, tends to bring the masses and balls still closer together. A motion is thus given to the arm of the torsion balance, and in consequence of the elasticity of the suspension wire, the balance performs a series of isochronous oscillations and ultimately comes to rest in a position in which the attraction of the two masses on the balls is exactly counterbalanced by the torsion of the wire.

The force developed by the leaden masses being exceedingly minute, not more than a fifty-millionth part of their weight, a very small disturbing force will prevent the success of the experiment, and accordingly many precautions are requisite. In Baily's experiments the torsion rod was enclosed in a mahogany case, gilt in the inside, wrapped round with thick flannel, and covered over with gilt paper, to prevent the radiation of heat, and consequent derangement from the currents of air thereby produced. The balls were also gilt and burnished, and the whole apparatus was surrounded by a close wooden frame, or case, having glazed openings, through which the motions of the torsion rod were observed by means of a telescope from a distant part of the room.

In order to deduce the mean density of the earth from the data furnished by the experiments, it is necessary to find expressions for the torsion developed in the wire, and for the attractive force of the masses on the balls, in that position of the arm of the balance at which it comes to rest under the action of the two forces, which then counterbalance each other. The theory is as follows:—

Let F denote the force (measured by the weight in grains) which, being applied hori-

zontally and perpendicularly to the arm of the balance at the unit of distance (one inch) from the suspension wire, causes the arm to pass through a unit of angular space, or describe an arc equal to the radius. Also, let F' denote the torsion actually developed by the attraction of the masses, a the distance of the suspension wire from the centre of the ball, and θ the angle of deviation of the arm from its first position. By the nature of the lever, the force required to produce a given effect is inversely as the distance of its point of application from the fulcrum, which is here the suspension wire; and according to the law determined by Coulomb, the force of torsion is directly proportional to the angle of torsion; therefore,

$$F' = F\frac{\theta}{a}.$$

The measure of this force F' is deduced from the time in which the oscillations of the balance are performed. The general formula [TORSION] for the torsion force is,

$$F = \frac{\pi^2}{n^2} \times \text{moment of inertia},$$

where $\pi = 3{\cdot}14159$, and n is the number of seconds in the time of an oscillation. In the present case the whole of the matter in each ball may be regarded as accumulated at its centre, and the matter in the rod may be neglected; hence in respect of each ball the moment of inertia is expressed by the mass (m) multiplied into the square of the distance of its centre (a) from the suspension wire, that is, by a^2m, consequently the inertia in respect of both balls is $2a^2m$, and the above formula becomes

$$F = \frac{2\pi^2}{n^2}\,a^2m.$$

Let w denote the weight in grains in each ball, g the accelerating force of gravity, and l the length of the seconds pendulum; then $w = gm$, and $g = \pi^2 l$, whence by substitution $F = \frac{2a^2w}{ln^2}$, and consequently, since $F' = F\frac{\theta}{a}$, $F' = \frac{2aw\theta}{ln^2}$.

Having obtained an expression for the torsion force, we have next to find the force of the attraction of the leaden masses. In respect of each mass let g' denote the force of attraction, r the radius, v the volume, and d the density; and in respect of the earth (assumed to be a sphere) let the same elements be respectively denoted by g, R, V, and D; also, let k denote the distance of the centre of the mass from the centre of the ball at the middle of the oscillation, and assume f to be the coefficient of gravity. Now, because the attraction of a sphere on a point without it is directly as its mass, that is, as its volume multiplied into its density, and inversely as the square of the distance of the attracted point from its centre, we have $g' = \frac{fvd}{k}$, and $g = \frac{fVD}{R^2}$; whence $\frac{g'}{g} = \frac{vdR^2}{VDk^2}$. But $\frac{v}{V} = \frac{r^3}{R^3}$, therefore $\frac{g'}{g} = \frac{r^3d}{RDk^2}$; consequently, since the attraction of the earth upon the ball is the same thing as the weight of the ball, or $g = w$, we have $g' = \frac{r^3dw}{RDk^2}$, and therefore

$$\text{attraction of both masses} = \frac{2r^3dw}{RDk^2}.$$

By the conditions of the problem this attraction is equal to, or balances, the torsion force F'; therefore, putting the two expressions equal to each other, we have $\frac{a\theta}{ln^2} = \frac{r^3d}{RDk^2}$; whence, finally, $D = \frac{r^3ld}{aRk} = \frac{n^2}{\theta}$.

In this expression for D, the mean density of the earth, all the quantities are supposed to be known excepting n and θ, and the object of the experiment is to determine their values. The angle θ is determined by observing the number of divisions, on a known scale, passed over by an index or pointer attached to the extremity of the arm of the balance, so that if β denote the value of one division of the scale in parts of an inch, λ the distance in inches between the suspension wire and the extremity of the index, and h the number of divisions passed over by the index when the arm of the balance moves from its position of rest *before* the mass is approximated to the ball, to its position of rest *after* the approximation, then $\theta = \frac{h\beta}{\lambda}$.

Cavendish gives the numerical values of the constants which enter into the expression for D as follows: $r = 6$, $l = 39{\cdot}14$, $a = 36{\cdot}65$, $k = 8{\cdot}85$, $R = 250800000$, all in inches; and d (the density of the leaden mass as compared with water) $= 10{\cdot}64$. He also had $\beta = \frac{1}{20}$, $\lambda = 38{\cdot}3$, whence $\theta = 1 \div 766$; and the substitution of these numbers in the formula gives $D = \frac{n^2}{10683h}$. There are, however, several corrections to be made on account of the attraction of the matter in the plank and mahogany case, and other parts of the apparatus, as also for the inertia of the arm of the balance, and for the variation of the masses on the balls according to the position of the arm, for the details of which we must refer to the memoir of Baily already cited. It may be noticed that the motion of the arm is very slow, the average time of a complete vibration in Cavendish's experiments having been from six to seven minutes.

The result obtained by Cavendish gave the mean density of the earth, as deduced from 17 sets of experiments, equal to 5·45, that of water being unity. Reich, from 57 experiments, found it to be 5·44. Baily's experiments were far more numerous and varied than those of his two predecessors. The torsion rod was suspended in different ways: by a single copper wire, as had been practised by Cavendish and Reich; and by double lines, as proposed by

Gauss; and in the latter case the substances used were silk fibres, brass wire, and iron wire. In order to ascertain whether the results would be affected in any way by varying the substance of the attracted body, the experiment was made not only with leaden balls attached to the ends of the torsion balance, but also with balls of platina, zinc, glass, ivory, and hollow brass, and with a torsion rod of brass without balls. The actual number of experiments recorded in the memoir is no fewer than 2,153; and nearly as many more, which had been made before the anomalies of the balance had been entirely got rid of, were rejected. The mean result from all the recorded experiments, without exception, gave the mean density of the earth equal to 5·675, with a probable error of ·0038.

Caverns (Lat. caverna). Few rocks are so compact as not to show occasionally hollow spaces and recesses, to which the name Cavern may properly be applied; but limestone caverns are so much the most numerous, the largest, the most important, and the most interesting of all, that they have attracted universal attention and caused the others to be neglected. Limestone caverns are certainly among the grandest and most instructive phenomena presented in nature. Vast natural tunnels penetrating for miles into the heart of the earth, multiplied infinitely by ramifications too small for man to follow, but quite large enough to allow of open water communication underground from one part of a country to another, are found in all limestone districts wherever the rock is hard and compact enough to form a durable roof. Such a rock is so broken, during hardening and elevation, as to admit of the percolation of water, and nothing but a sufficient rainfall is necessary to insure a constant supply of water, which, running through the crevices, enlarges and multiplies them, and ends by producing a group of caverns.

The foundation of all that is remarkable in these caverns is the solubility of limestone in water. Wherever rain falls and enters the earth, it dissolves some portion of the limestone with which it comes in contact. Small as this may be, still if the water constantly courses through the same crevices, the result will soon become evident. The water continues to flow; but when saturated with carbonate of lime, it is in a condition to redeposit it if circumstances are favourable. Where it is stopped in its progress, and where part of the water is evaporated by the air that also passes through the cavern, this redeposit takes place, for by the removal of the water the dissolved carbonate of lime is left behind. It is either added to a pendant suspended from the ceiling or roof of the cavern, or to a column rising from the floor where a constant drip takes place. Thus the limestone removed from the walls of a crevice a long way overhead may serve to produce in the interior an additional film on a portion of a column, which is a *stalactite* or *stalagmite* according as the water drips from or upon it.

It is quite impossible to exaggerate the amount of complication producible by these simple means, namely, the removal of portions of limestone from one place and their depositions in another. The caverns originate in crevices formed by the irregular fracture of the rock. Out of these hollow spaces are concocted by the action of running water natural chambers of all dimensions. Into these hollow spaces again are packed away the most fanciful and singular examples of nature's handiwork, imitative as it were of human devices. Columns, pilasters, churches, sculptured groups of men and animals, organs, curtains, and almost all conceivable objects, are found or fancied by those who thread the narrow passages or cross the lofty halls with a few glimmering lights to guide them in their way.

The celebrated grotto of Antiparos in Greece, the Adelsberg caverns in Carniola, the Mammoth Caves of Kentucky, the caverns in Bavarian Switzerland, and a host of others in France, Belgium, Spain, Sicily, Hungary, &c.; others in the principal limestone districts of England as in Somersetshire, Derbyshire, and Yorkshire; others again in the Brazils; others in Australia, are all essentially of the same nature. They are results of water action on broken and fractured limestones.

Granite also is frequently penetrated by water on a sea coast and is worn into caverns. The shores of the Channel Islands and the coasts of Brittany and Cornwall are alike examples of this. But here the action of water is chiefly mechanical, and the result is on a smaller scale. The water penetrates the softer parts of the rocks, undermines them, and assisted by the constant tidal action of the waves (removing all broken material that comes within its influence) it at length produces systems of caverns on a large scale.

The contents of caverns are sometimes extremely interesting. Granite caverns where the range of tide is considerable are sometimes covered with the lower forms of animal life, such as zoophytes and sponges. Limestone caverns are more frequently traversed by fresh than salt water, but they also are favourable for the growth of marine plants and animals of considerable interest.

It is, however, chiefly the materials buried in the floor, and often cemented by and covered up with limestone, that are most interesting in limestone caverns. Bones of quadrupeds are sometimes so abundant that it is difficult to understand how so many can have been accumulated. They are generally the bones of extinct animals, bears, hyænas, elephants, and rhinoceroses, and with them occasionally are indications of men. Thus caverns are crowded with interest of all kinds to the geologist, the archæologist, the naturalist, and the artist, and few natural phenomena are more striking and varied than those which they present.

Cavetto (Ital.). A hollow moulding used in Architecture, whose profile is a quadrant

of a circle; it is commonly introduced in cornices.

Cavia. The Linnæan generic name of a Cuvierian family of Rodents, including the guinea-pig, Agûti, Paca, and Capibára.

Caviare. The salted roe of the sturgeon, much esteemed by the Russians as an article of food, and frequently brought as a delicacy to this country.

Cavicorns, Cavicornia (Lat. cavus, *hollow*, and cornu, *horn*). The name of the tribe of Ruminants comprehending those which have the horns hollowed out like a sheath and implanted on bony processes of the os frontis, as in the antelope.

Cavitaries, Entozoa Cavitaria (Lat. cavitas, *a hollow*). Intestinal worms, or Entozoa, which have an intestinal canal floating in a distinct abdominal cavity.

Cawk. A term applied by miners to a massive earthy-looking variety of sulphate of baryta, which is very common in Derbyshire.

Cayleyan. The envelope of the pairs of right lines which constitute polar conics relative to a cubic curve, or, what is the same thing, the envelope of the right lines joining corresponding points of the Hessian of the cubic. The name was proposed by Cremona, in his *Teoria Geometrica delle Curve Piane.* The curve in question is of the third class and sixth degree, whose properties were first investigated by Cayley in the *Phil. Trans.* of 1857. It has since been referred to by several English and Continental writers; a short notice of it is given in Salmon's *Higher Algebra*, p. 113—its tangential equation being the first evectant of the fundamental quartinvariant of the cubic.

Cayman or Caiman. A name which, according to Marcgrave, is applied to the crocodiles by the negroes of Congo. It has been diffused over the new continent by the negroes, and applied to most of the American species indiscriminately; but by Cuvier it is restricted to the alligators. [ALLIGATOR.]

Cebadilla. The seeds of *Asagræa officinalis*, from which veratria is obtained.

Cebus (Gr. κῆβος, *a monkey*). A genus of Platyrrhine prehensile tailed monkeys found in equatorial America. Many species are known to zoologists, presenting more or less amount of variation. The specific value of these forms has been contested by many zoologists, who have proposed to refer nearly all of them to one or two species. The *Cebus apella* and *capucinus*, which are found near the Orinoco, are examples of the genus.

Cecropia (Cecrops, a mythical king of Athens). A genus of *Artocarpaceæ*, occurring in tropical South America, and having the very minute flowers arranged on short cylindrical spikes, several enclosed within a large bract. The female flowers are succeeded by short spikes of fleshy one-seeded fruits. *C. peltata* is the Trumpet-tree of the West Indies, its hollow branches being used for musical instruments, and its hollow stems for drums. The bark is astringent. The wood is light, and when dry is used by the Indians for producing fire by means of friction.

Cedar (Lat. cedrus, Gr. κέδρος). The common name of various trees, but more especially applied to the Cedar of Lebanon (*Abies Cedrus*) and the plants closely allied to it.

Cedrelaceæ (Cedrela, one of the genera). A very important, though small, natural order of plants, allied to *Meliaceæ*, from which they differ in having winged indefinite seeds. They belong to the Rutal alliance, and have consolidated capsules, and either deeply monadelphous or free stamens. Most of the species are trees of large size. *Swietenia Mahagoni* yields mahogany, in the woods of the Spanish Main; from *Chloroxylon Swietenia* comes Indian Satinwood; while the Yellow-wood and the Cedar of New Holland are the produce of others. In general their bark is powerfully astringent; that of *Soymida febrifuga* and mahogany itself is a potent febrifuge; that of *Cedrela Toona* is a most valuable tonic in the Malayan archipelago; and *Khaya senegalensis* yields a similar remedy for the dangerous fevers of the Gold Coast.

Cedriret. An orange-red crystalline body contained in creosote.

Cedrus. [CEDAR.]

Ceiling (formerly written *seeling*: derivation uncertain). The upper, or horizontal, or curved surface of an apartment, opposed to the floor, usually finished with plasterer's work; it also in some parts of the country means the rendering coat of a partition. In executing ceilings the best method is to nail the laths to ceiling joists, or to brackets, and to add the work in a series of coats composed of lime and hair, putty, or plaster, technically called gauged stuff; common ceilings are executed with plaster without hair, the same as the finishing coat in walls left for paper.

Celastraceæ (Celastrus, one of the genera). A natural order of shrubby Exogens, formerly confounded with *Rhamnaceæ*, but separated by Brown, chiefly because of the relation which the stamens bear to the petals and the different æstivation of the calyx. They are allied, according to Brongniart, to *Malpighiaceæ*, through *Hippocrateæ*, a small order which scarcely differs from this. *Celastraceæ* are natives of the warmer climates, especially of the tropics, and their general characters appear to be of a stimulating acrid nature. The Khât of the Arabs is procured from *Catha edulis.*

Celeres (Lat.). In the traditional history of Rome, a body of cavalry instituted by Romulus. They consisted of those among the citizens who were rich enough to furnish a horse. They are said to have been 300 in number, and to have been subdivided into three centuries, under the name of Ramnes, Titienses, and Luceres. It is said that the number of the centuries of the Celeres was raised to six by Tarquinius Priscus, and that this was the origin of the Equites or knights, who in after times formed a separate class of citizens. (See

Sir G. C. Lewis, *Credibility of Early Roman History*, i. 414.)

Celestine (Lat. cœlum, *the sky*). Native sulphate of strontia. When pure it consists of 43·6 per cent. of sulphuric acid and 56·4 of strontia; but it is often mixed with the carbonates of lime and baryta, or with oxide of iron. It occurs crystallised, fibrous, stellated, and massive, and is colourless, grey, and sometimes of delicate tints of blue, approaching to sky-blue; whence the name Celestine. It is very brittle, has a shining lustre, and varies from transparence to subtranslucence.

Considerable quantities of Celestine are found in the New Red Marl of the neighbourhood of Bristol, where it is made into nitrate of strontia, which forms the basis of the 'red-fire' used at the theatres and in pyrotechny. Fine transparent prismatic crystals are found associated with sulphur and gypsum in the sulphur mines of Sicily. Other localities are Edinburgh, Conil in Spain, Bex in Switzerland, France, Hungary, Dornberg near Jena, Frankstown in Pennsylvania, &c.

Celestines. A religious order, so called from its founder, Peter Morrone, afterwards Pope Celestine V., who established it A.D. 1254. It was suppressed A.D. 1778.

Celibacy (Lat. cælebs, *unmarried*). The legal condition of unmarried persons. This condition was subjected by the laws of the Roman emperors to a variety of penal consequences. The most remarkable of their enactments, and that on which the subsequent jurisprudence on this subject was in a great measure founded, was the *Lex Julia* or *Papia-Poppæa*, enacted under the authorisation of Augustus. By these laws unmarried persons could receive nothing by will from strangers, and were subjected to many other legal disabilities [LAW, ROMAN]; from which, however, they were successively relieved by later laws passed in the decline of the empire, and especially after the mistaken zeal of the Christian divines of that age had invested celibacy with attributes of sanctity. It was at an early period in the history of the Christian church that ministers were exhorted to celibacy by those who laid claims to a higher degree of sanctity. At the council of Nice, in A.D. 325, the proposition to enforce it as a general law was rejected. But at that of Arles, in 340, it was adopted; married persons being indeed held admissible into the church, but only on the terms of separating from their wives on ordination. It had become the common practice of the Latin church in the reign of Gregory the Great (end of the sixth century), and was more fully enforced, after a period of relaxation, in the eleventh. It was proposed to the council of Trent by Charles V. (in the interim), that married priests should retain their wives; but this was rejected. In the Greek church, celibacy was ordained for bishops at the council of Tralles, A.D. 695; but clergymen below the degree of episcopacy are allowed to marry. Hence the higher dignities of that church are necessarily filled by monks.

Cell. In Anatomy, a primary microscopic vesicle, of larger average size than the nucleus, composed of membranous cell-walls, with usually liquid contents, round or oval, and sometimes flattened like a scale. With a few exceptions—e. g. the mammalian blood-discs and old cells of the epidermal or adipose systems—the primary cell contains a nucleus.

Cella (Lat.). In ancient Architecture, the part of a temple within the walls was called the cella; or in Greek the *naos*. The part of the temple in front of the cella was called the *pronaos*; the part in the rear of it, the *posticum*.

Cellepores, Cellepores (Lat. cella, *a cell*, and porus, *a pore*). A genus of flexible cellular Polyps, including those in which each of the cells is pierced with a minute pore.

Cellular Beam. An application of wrought iron for the purposes of girders and beams, in which wrought-iron plates are riveted with angle irons, in the form of longitudinal cells with occasional cross struts. The experiments on which engineers have founded their practice in the application of these beams may be found in Fairbairn *On Cast and Wrought Iron*, and in Clark, *Britannia and Conway Bridge*; from the last of which the following empirical rule is derived: Make the depth equal to $\frac{1}{16}$ of the length; calculate the dimensions of the lower flanges so that the tension shall not exceed five tons on the square inch, taking the tension at twice the sum of the load to be carried, and the weight of the beam itself; make the sectional area of the top flange one-fourth (or one-third) more than that of the bottom, and the sectional area of the two sides equal to about half the area of the bottom.

Cellular Membrane. In Anatomy. [MEMBRANE.]

Cellular Tissue. In Botany, a substance consisting of little bladders or vesicles of various figures adhering together in masses. It constitutes the principal part of all plants, and may be regarded as an organic basis, into which other kinds of tissue are introduced, or from which they are created. It exists exclusively in the embryo of a plant until vitality has been excited, and new forms of tissue developed in consequence. [BOTANY.]

Cellulose. The name of the matter composing the walls of the cells and vessels of plants. It is insoluble in most menstrua, and is generally characterised by chemical inactivity.

Cement (Fr. cément; Lat. cæmentum, *rubbish* or *mortar*). In Anatomy, the substance which joins together the plates of compound teeth, like those of the elephant, and which fills up the folds and cavities in the teeth of Ruminants and Pachyderms; and which also covers all that part of a simple tooth which is not coated with enamel. The cement is characterised, like true bone, by the presence of the Purkinjean corpuscles.

CEMENT. In Building, a mixture of carbonate of lime and silicate of alumina in the

proportions of 16 to 64 per cent. of the latter to 84 to 36 of the former, which possesses the faculty of setting rapidly under water, and of increasing in hardness with time. There are two descriptions of cements, the *natural* and the *artificial*. The former is obtained by calcining natural stones; the latter is obtained by the calcination of a mixture of chalk and clay. The Roman cements are types of the first class, and Portland cements of the second; these names having reference to some supposed resemblance to Roman mortars and to Portland stone.

Cementation. When a solid body is surrounded by the powder of other substances, and the whole heated to redness, the process is termed *cementation*. Iron is said to be converted into steel by cementation with charcoal.

Cemetery (Gr. κοιμητήριον, *a place for sleeping*). In Architecture, an area or a building wherein the dead are interred. The most celebrated public cemeteries of Europe are those of Naples, Bologna, Pisa, the more modern one of Père la Chaise of Paris, and that at Kensal Green near London. That of Pisa is particularly distinguished by the beauty of its form and architecture, which is early Italian Gothic. It is 490 feet long, 170 feet wide, and 60 feet high, cloistered round the four sides, and contains many shiploads of earth which the Pisans brought from Jerusalem. It was long a matter of regret that England could boast of no public cemetery; but in 1832 a company was established for the construction of the first undertaking of this description, and it accomplished its object by the creation of the Kensal Green cemetery. Subsequently to that operation, numerous other cemeteries have been established in the outskirts of London; and now that intramural interments are forbidden, there can be no longer any doubt of their advantages, whether the feelings of the living, or respect for the dead, be considered.

Cenobio (Gr. κοινόβιος, *living in common*). A term invented by Mirbel to denote a regular fruit divided from the base into several acephalous pericarps; that is to say, pericarps not marked on the summit by the stigmatic scar, the style having been inserted at their base, as in *Labiatæ*, *Boraginaceæ*, &c.

Cenotaph (Gr. κενοτάφιον). A monument, or a tomb, erected to the memory of some person buried elsewhere, or not found for burial at all.

Censor (Lat.). In Ancient History, the title of two Roman magistrates originally created for the purpose of taking the census, or register of the number and property of citizens. But their powers were much increased subsequently, when they had the inspection of the morals of the citizens committed to them, with authority to degrade senators and knights from their respective orders, and remove other citizens from their tribes, depriving them of all their privileges except liberty; which was termed making them Ærarians. They had also the power of making contracts for public buildings and the supply of victims for sacrifices.

The censors were originally appointed for a whole lustrum; but by law of Mamercus Æmilius, B.C. 433, the term of office was limited to eighteen months. The magistracy was confined to patricians, until C. Marcius Rutilus, a plebeian, was elected in B.C. 351. No person might be twice invested with it; and if one of the censors died, another was not substituted in his room, but his surviving colleague was obliged to resign. The office of censor was abolished under the emperors, who, however, exercised the greater part of its functions.

Census (Lat.). In Roman History, a population return of the citizens, including a valuation of each man's property, and a registration of his tribe, family, children, and servants.

The secondary senses of the word are: a tax levied according to the above-mentioned valuation; and the amount of any individual's property.

The term Census, in modern political phraseology, signifies an enumeration of the inhabitants of the country; such as has taken place in England by Act of Parliament every ten years from 1801 to 1861.

Centaurs (Gr. κένταυρος). In Greek Mythology, a fabulous race of beings, half-man and half-horse, who are said to have inhabited part of Thessaly, and waged constant war with the hostile tribe of Lapithæ. The word is identified with the Vedic Gandharva. (Bréal, *Le Mythe d'Œdipe*, p. 10.)

Centaurus, the Centaur. One of the forty-eight ancient constellations formed by Ptolemy, situated in the southern hemisphere, and under the tail of Hydra. The Centaur is represented as half-man, half-horse; the human part only of the figure is visible above our horizon.

Centigrade Division. The division into *grades* or degrees by hundredth parts. A unit of any denomination being divided into 100 equal parts, forms a centigrade scale; but the term most frequently occurs in scientific works, in reference to the division of the scale of the thermometer. The fixed points of the thermometric scale are the points at which water freezes on the one hand, and boils on the other; the space between these two points being divided into 100°, the centigrade scale is formed. In Fahrenheit's scale, which is usually applied in common life to the thermometer in this country, the same space is divided into 180°; a degree of the centigrade scale is therefore greater than a degree of Fahrenheit in the proportion of 180 to 100, or of 9 to 5. Any number of degrees, therefore, on the centigrade scale, being multiplied by 9 and divided by 5, will give the equivalent number of degrees of Fahrenheit. But in comparing temperatures expressed by the two scales, it is necessary to recollect that the zero of Fahrenheit's scale is not placed at the freezing point, but 32° below it. An example will best show how this is to be taken into account. Let it be required to express on Fahrenheit's scale the temperature corresponding to 10° centigrade. Here

$10 \times 9 + 5 = 18$; to this add 32, and we have $18 + 32 = 50$; so that a temperature of 10° of the centigrade scale corresponds to one of 50° of Fahrenheit's. [THERMOMETER.]

Centipede (Lat. centipeda). The name of the Myriapodous insects belonging to the genus *Scolopendra* of Linnæus. They are wingless; and the largest species possess, when full grown, more than fifty and less than two hundred pairs of feet.

Cento (Lat.; Gr. *κέντρων, a patchwork cloak or garment*). A word employed to designate a collection of separate verses from the works of one or more poets, arranged so as to form a distinct poem. The only classical example of a cento left to us is that of Ausonius, who composed a nuptial idyll out of Virgilian verses; in which, however, the words are also perverted into a new meaning. In his prologue to this piece Ausonius describes the cento, and gives rules for its composition.

Central Axis. [COMPOSITION AND RESOLUTION OF FORCES AND ROTATIONS.]

Central Forces. Forces, whether attractive or repulsive, whose directions always pass through a fixed point. On account of its applications to the great problems of physical astronomy, the theory of central forces is justly considered as one of the most important in mechanics, and as such receives due consideration in every good treatise on the subject.

The two most important laws of central forces have reference to the description of areas by the radius vector to the moving body, and to the variation of the *vis viva* or product of the mass of that body into the square of its velocity. According to the first, equal sectorial areas are described by the radius vector in equal times, no matter what may be the law of the central force, that is to say the variation of its intensity with the distance of the body, or the position of the body in its orbit. According to the second, the gain or loss of *vis viva* during the passage of the body from one point to another of its orbit depends, solely, upon the distances of these points from the centre, and not upon the nature of the orbit. It follows as a consequence of the first of these laws, that the velocity of the body at any point of its orbit is inversely proportional to the perpendicular let fall from the centre upon the tangent at that point.

Again, the orbit and centre of force being known, the law of the latter can be determined; and conversely, the centre and law of force being given, the nature of the orbit can be found, its precise form and magnitude depending then merely upon the velocity and direction of the body's motion at any one particular point. Thus a body in motion under the action of a central attractive force directly proportional to the distance would necessarily describe an ellipse *concentric* with the force, and the periodic time would be independent of the magnitude of this ellipse and dependent solely upon the absolute magnitude of the force—to the square root of which, in fact, it would be inversely proportional. On the other hand, the orbit being an ellipse and the centre of force coincident with one of its foci, this force must vary inversely as the square of the distance, and the square of the periodic time must be directly proportional to the cube of the semi axis major of the orbit and inversely proportional to the absolute intensity of the force.

Now according to Kepler's observations the heliacal radius vector of every planet of our system describes equal areas in equal times, the orbit of every planet is an ellipse in one of whose foci the sun is situated, and the squares of the periodic times of the several planets are proportional to the cubes of the semi major axes of their orbits; whence Newton was able to infer, first, that the planets were acted upon by central forces whose source is the sun; secondly, that each of these forces varied inversely as the square of the distance; and lastly that the absolute central force is the same for all the planets. Thus the great problems of celestial mechanics were completely solved, and the universality of gravitation, that is to say the action of the planets on each other according to the same laws, was afterwards found sufficient not only to account for the secondary irregularities which more accurate observation has detected in the orbits of the celestial bodies, but to predict the existence of one (Neptune) which had not hitherto been observed.

Central Sun. In Sidereal Astronomy, the name given to the body about which the sun, and all the stars in the great cluster or nebula to which the sun belongs, is assumed to be revolving. M. Mädler, of Dorpat, has published a paper under this title, in which he attempts to assign the real motions of the stars, and consequently the position of the central point, in reference to a dynamical theory. He thinks there is no reason for supposing that there exists anywhere a star of such magnitude as to dominate the motions of others as the sun does the motions of the planets; but if we suppose the stars of our stellar cluster to be pretty uniformly distributed, and the form of the limit of the cluster to be nearly spherical, or a surface compressed between two planes, as is supposed to be the case of the Milky Way, then, whatever the law of attraction may be, the stars near the centre will move with much smaller linear velocity than the distant one; and this difference of real velocity will give rise to apparent motions by comparison of which the relative distances from the centre may be assigned. Applying these considerations to the apparent motions actually observed, and assuming the direction of the sun's motion in the heavens to be that which has been determined by Argelander and others, Mädler shows that a point somewhere in the group of the Pleiades, and probably not far from the star *η Tauri*, possesses the characteristics of the central point. Having thus obtained, approximately, the position of the central body, Mädler proceeds to discuss its probable distance from our sun, and the velocity

of the sun's orbital motion about the centre. Assuming the star 61 *Cygni* to be at the same distance from the central body as the sun is, and the distance of 61 *Cygni* from the sun to be known from the parallax found by Bessel, he finds from these assumptions, and from the observed proper motions of 61 *Cygni* and η *Tauri*, that the parallax of η *Tauri* is 0″·0061, or that its distance is thirty-four millions of times as great as the distance of the earth from the sun. The proper motion of η *Tauri* gives for the periodic time of our sun round the centre 18,200,000 years; and the velocity of our sun in its orbit round the central sun is about thirty English miles in a second of time. (*Monthly Notices of the Royal Astronomical Society*, vol. vii. No. 12, February 1847.)

Centre (Gr. *κέντρον, a sharp point*). The meanings of this word as employed in Geometry and Mechanics are so varied, that a general definition is scarcely possible. It will be best, therefore, to consider separately, and in their proper places, the most important applications of the term.

When applied to a curve or surface, the term Centre or Geometrical Centre denotes a point with respect to which all the points of the curve or surface are symmetrically situated; that is to say, every right line through the centre of a curve or surface will cut the latter in points which, taken two and two, are equidistant from that centre. With respect to curves and surfaces of the second order, the position and properties of the centre are well known, and are fully described in every treatise on the subject. The centres of curves and surfaces of higher order have been less studied; a valuable memoir on the subject, by Steiner, will be found in Crelle's *Journal*, vol. xlvii. p. 7.

For curves of an odd order it is evident that the centre must be a point of inflexion on the curve itself; whilst for those of even order the centre will not in general be on the curve; should it do so, however, it would necessarily be a multiple point of an even order.

In order that a and b may be the coordinates of the centre of a curve of the n^{th} order whose equation is $F(x,y)=o$, all the terms of the $(n-1)^{th}$, $(n-3)^{th}$, $(n-5)^{th}$ &c. dimension in the transformed expression $F(x+a,\ y+b)$ must vanish. This will give $\left(\frac{n+1}{2}\right)^2$ or $\frac{n(n+2)}{4}$ conditions according as n is odd or even. Now the greatest number of conditions that the curve can satisfy is $\frac{n(n+3)}{2}$, so that besides having a centre at a given point, only $\frac{1}{4}(n^2+4n-1)$ additional conditions can be imposed upon a curve of odd order, and only $\frac{1}{4}n\,(n+4)$ upon a curve of even order. Thus a conic is determined by its centre and 3 points through which it passes; a cubic by its centre and 5 points. To demand that a curve shall possess a centre is equivalent to imposing $\frac{1}{4}(n^2+2\,n-7)$ or $\frac{1}{4}(n^2+2n-8)$ conditions according as the order is odd or even; so that it is only in the case of conics that such a demand is without influence upon the number of other imposable conditions. For instance, through 8 points we cannot in general draw a cubic which shall have a centre; through 7, however, we can; and Steiner shows that, in general, the problem is susceptible of nine distinct solutions.

Centre. In Building, the temporary support, or framing, on which the materials of an arch are laid, during the progress of the work. The rigidity of such framing, and the ease with which it may be struck, have considerable influence upon the successful execution of the arch; and therefore centring has always constituted an important branch of carpentry.

As a rule, the frames which support the centring are brought as close together as possible, and they are usually made about seven feet apart. They are made to bear either directly on the piers; or they may rest upon struts; or they may have intermediate bearings, which will diminish the clear span. Upon these frames are placed the boards, or laggings, intended to receive the intrados of the arch; when small materials, such as rubblestone or bricks, are used, the laggings are laid with a close joint; when the work is executed in large wrought stones, the laggings are laid at intervals. When a level tie beam is omitted so as to leave head room in a centre above the springing of the arch, such a centre is called a *socket centre*. In designing a centre of large span, the important principles are: 1st. That the frames should be put together so as to resolve all the thrusts into vertical efforts upon their points of support; 2nd. That the frames should be maintained in their vertical position; 3rd. That the tendency of the centre to rise towards the crown under the influence of the masonry should be counteracted; and 4th. That the centre should be able easily to be withdrawn. In executing an arch the custom is to carry up the two sides equally, and to weight the crown, so as to avoid any deformation of the centres; and most constructors exaggerate the height of this portion of the centre in order to compensate for the compression of the joints; in the old bridges this compression was very considerable, but in modern works it is almost entirely obviated. In striking the centres, care must be taken that there be no unnecessary jar to the masonry; a condition which is hardly to be avoided with the ordinary method of resting the foot of the centres on wedges. (Perronet, *Mémoire sur le Cintrement et le Décintrement*, Paris 1809; Robison, *Mechanical Philosophy*, London 1822; Tredgold, *Carpentry*, London 1828; Simms' *Practical Tunnelling*, London 1844.)

Centre of Buoyancy. [Hydrostatics.]

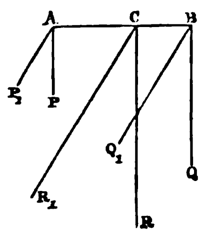
Centre of Curvature. The centre of the circle of curvature. [Curvature.] In plane curves the centre of curvature is the intersection point of consecutive normals, and its locus is the evolute. In non-plane curves it is usually distinguished as the *centre of absolute* or *principal*

curvature; it is the point where the osculating plane is pierced by the intersection line of two consecutive normal planes. Its locus is no longer, as in plane curves, an evolute of the curve, though this locus is situated on the polar developable which contains all such evolutes. [CURVE.]

Centre of Equilibrium. A point from which, if a system of bodies were suspended, the whole would remain in equilibrium. Thus, the fulcrum or point of support of a lever is its centre of equilibrium.

Centre of Figure. By this term is generally understood the centre of gravity of the figure, considered as a homogeneous body having weight.

Centre of Gravity. The point through which the resultant of the weights of the several component particles of a body always passes. These weights are of course considered as forming a system of parallel forces; the earth's centre, towards which each particle is really attracted, being infinitely distant when compared with the dimensions of bodies with which we are concerned. The existence of such a point as the one defined may be easily established from the fact that the resultant R of two parallel forces P and Q applied at the extremities of a line AB is always parallel to the components; equal to their sum; and passes through a fixed point C of the line AB, *no matter how the inclination of the parallel forces to AB may be altered.* For instance, if without altering the parallelism or the magnitudes of P and Q, their directions were changed to AP_1, BQ_1, the resultant $R_1 = R$ would still divide AB in C, so that the ratio CB : CA should be equal to P : Q, or $P_1 : Q_1$.



If the centre of gravity of a body be fixed, therefore, it will remain in equilibrium however it may be turned around it. This principle, together with the equally simple one, that the resultant of a system of parallel forces is the same as that of the resultants of any groups of forces into which the original system may be divided, suffices for the determination of the centre of gravity of any body whatever. In fact, if m_1, m_2, m_3 &c. be the masses (proportional to the weights) of a number of material particles whose distances from any plane are x_1, x_2, x_3 &c., then the distance x of their centre of gravity from the same plane will satisfy the condition

$$x\,(m_1 + m_2 + \ldots) = (m_1\,x_1 + m_2\,x_2 + \ldots),$$

or as it is usually written $x\Sigma m = \Sigma mx$. The sum Σm represents, of course, the total mass of the system which, as well as Σmx, will in the case of a body be represented by a triple definite integral. The whole theory of the centre of gravity being contained in the above equation, and fully developed in every good treatise on mechanics, it will be sufficient to notice here a few of the most remarkable properties. When a homogeneous body possesses a geometrical centre, the latter is always its centre of gravity. The centre of gravity may of course fall outside the body. Thus the centre of gravity of a thin homogeneous wire bent in the form of a circular arc is in the radius drawn to the middle of the arc, and its distance from the centre of the circle is to the radius as the chord of the arc is to the length of the latter. The centre of gravity of a plane homogeneous triangular thin plate is the common intersection of the three lines which join each angle to the middle of the opposite side. Mechanically the centre of gravity of any thin plate whatever may be found by suspending it successively from any two points, and, after equilibrium has established itself, drawing, by means of a plumb-line, the vertical through the point of suspension. The intersection of the two lines so drawn will be the centre of gravity. The centre of gravity of a homogeneous triangular pyramid is in the line which joins the vertex with the centre of gravity of the base, and has an altitude equal to three-fourths of that of the pyramid. Amongst the most important *general* properties of the centre of gravity, the following deserve notice. If the mass of each particle of a system, invariable in form, be multiplied by the square of its distance from a given point, the sum of the product will be a minimum when the point coincides with the centre of gravity: it will be invariable for all points equidistant from the centre of gravity, and it will exceed the minimum sum by the product of the total mass into the distance of the point from the centre of gravity. Further, the sum of the products of every two masses and the squared distance between them is equal to the above minimum sum multiplied by the total mass. (Lagrange, *Mécanique Analytique*.) If a number of forces in equilibrium around a point be represented in direction and magnitude by right lines from that point, the latter will be the centre of gravity of equal masses, situated at the other extremities of these lines.

Many geometrical applications of the properties of the centre of gravity have been made. [BARYCENTRIC CALCULUS and GULDIN'S THEOREM.] The centre of gravity of a number of mathematical points, considered as representatives of equal masses, is called the *centre of their mean distances*. In the case of n such points whose distances from any plane are $x_1, x_2 \ldots x_n$ the distance x from the same plane of the centre of mean distances will be

$$x = \frac{x_1 + x_2 \; . \; . \; . \; + x_n}{n}.$$

Centre of Gyration. [GYRATION.]

Centre of Oscillation. [OSCILLATION and PENDULUM.]

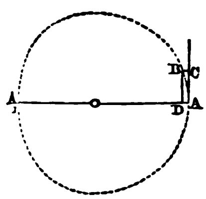
Centre of Spherical Curvature. The centre of the osculating sphere of a non-plane curve. It is a point equidistant from four

consecutive points on the curve, and lies, consequently, in three consecutive normal planes, or two consecutive polar lines; hence it is a point in the cuspidal edge of the polar developable.

Centres, Harmonic. [HARMONIC CENTRES.]

Centres of Principal Curvature. The centres of curvature of the two normal sections at any point of a surface. They coincide with the only two points in which the normal is intersected by consecutive normals. The locus of the centres of principal curvature, usually called the *surface of centres*, consists of two sheets to each of which every normal of the original surface is a tangent. The properties of this surface were investigated by Monge (*Application de l'Analyse à la Géométrie*), and have since been studied by various other authors. The excellent treatise on Surfaces by Dr. Salmon may be consulted on the subject with advantage.

Centrifugal and Centripetal Forces. These are usually defined as the forces which urge a body to avoid (fugere) or seek (petere) a centre. Owing, however, to a prevalent vagueness in the use of these terms, it will be well to illustrate their meaning in one special case. Suppose a body to rotate with a constant angular velocity around a fixed axis, then every point A will describe a circle ABA, in a plane perpendicular to that axis, of which the centre O will be a point in the axis itself. If perfectly free, the point A would describe the right line AC tangential to the circle; but not being permitted to do so, it exerts a certain constant strain in the direction of the radius OA, which strain calls forth an equal resisting force. The strain in this case is called the *centrifugal* force, the force of resistance the *centripetal*. To measure the latter, and therefore also the former, it is only necessary to consider the space AD through which the body has been urged by it during the time-element required for the description of the elementary arc AB. Calling F the accelerating centripetal or centrifugal force, we have on the one hand [ACCELERATION] $F = \frac{2AD}{t^2}$, and on the other, by geometry, $AD = \frac{AB^2}{AA_1} = \frac{AB^2}{2r}$, where r is the radius of the circle; consequently



$$F = \frac{1}{r} \cdot \frac{AB^2}{t^2} = \frac{V^2}{r},$$

V being the velocity with which A moves in the circle. Hence the centrifugal force in a given circle is directly porportional to the square of the velocity.

If the time in which a complete rotation is made be represented by τ, then $V = \frac{2\pi r}{\tau}$ and $F = \frac{4\pi^2 r}{\tau^2}$; that is to say, the angular velocity being the same, the centrifugal forces in two circles are proportional to their radii. Thus, considering the earth as a sphere of radius R, the radius of the circle described by a body at a point whose latitude is λ will be R cos λ, and F and f being the centrifugal forces at the equator and at the point in question, we have $f = F \cos \lambda$. If moreover f be resolved into two components, one horizontal and the other vertical, the latter will have the magnitude $f \cos \lambda = F \cos^2 \lambda$, will be directly opposed to gravity, and thus tend to diminish the weight of the body. At the equator the diminution of gravity owing to centrifugal force amounts to $\frac{1}{289}$th of what gravity would be were there no rotation; so that if the earth rotated with $17 = \sqrt{289}$ times its present velocity, bodies at the equator would have no weight whatever. The above result may also be expressed by saying that the force of gravity at the poles, where there is no centrifugal force, exceeds that at the equator by $\frac{1}{289}$th of the former. This is on the assumption that the earth is a homogeneous sphere; its actual form, however, is that of an oblate spheroid, in consequence of which the force of gravity at the poles is still further increased and the above ratio augmented to about $\frac{1}{200}$th.

By the term Centrifugal Force as applied to a body describing any curve in space, is usually understood the force in virtue of which it is deflected from a rectilineal path. At the instant under consideration we may in fact conceive the body to be moving in the circle which osculates its actual trajectory, so that if ρ denote the principal radius of curvature of the latter and v the velocity of the body, $\frac{v^2}{\rho}$ will be the expression for the centrifugal force.

Centrifugal Machine. A machine moved by the centrifugal force of water; frequently called, from its inventor, *Barker's Mill.* It consists of a hollow metal cylinder or pipe of metal placed upright, and resting on a pointed steel pivot at A. The pipe is widened or extended into a funnel shape at the top B, and is kept in its position by a vertical steel axis CD, passing through a frame at the top. Towards the lower extremity, two or more small pipes AE, AF, with closed external ends, are inserted at right angles to the axis. In the side of each of these an orifice is made as near as possible to the end, and on opposite sides, so that water from them may spout horizontally in opposite directions. Water is conveyed into the funnel at the top, through the pipe G, in such quantities that the tube is kept constantly full, while the discharge is going on at the orifice near the extremities of the horizontal pipes. In this state of things the resistance or reaction generated by the water issuing from

the side holes is such as to throw the vertical pipe, with its arms and axis, into rapid rotatory motion; and this axis may communicate its motion or power to wheel-work or machinery, or to a millstone connected with its upper end. (*Library of Useful Knowledge*, 'Treatise on Hydraulics;' *Ferguson's Lectures*, by Brewster; Lardner's *Cabinet Cyclopedia*, 'Hydrostatics and Pneumatics.') A machine of the same construction, but having the arms at the upper end, and turned rapidly by means of a wheel and pinion, was invented by Mr. Erskine for raising water. Centrifugal Machine is also used synonymously with *Whirling Machine*, an apparatus for the extraction of water from moist substances by centrifugal action. This machine is sometimes called a hydro-extractor.

Centripetal (Lat. centrum, and peto, *I seek*). In Botany, a term employed in describing the inflorescence of plants, when, in the unfolding of a head of flowers, those at the circumference open first, and those in the centre last. It is also used by carpologists in describing seeds when the apex of an embryo is directed towards the centre of a fruit.

Centriscus (Gr. *κέντρισκος*). A genus of Acanthopterygious fishes, having the foremost dorsal placed far backwards, and with its first spine remarkable for its length and strength; the mouth is slender and elongated, whence they have obtained the name of 'sea-snipes.'

Centrum (Lat.; Gr. *κέντρον, centre*). A term applied by Fries technically to designate the typical division of the groups of species and genera, in his circular arrangement of *Fungi*. Many generic names are compounded, having this word for their root, as *Centrogaster*, *Centrolophus*, *Centropristis*, and *Centronotus*, all genera of spiny-finned fishes; *Centropus*, a genus of birds, allied to the Cuckoos, &c.

Centumviri (Lat.). In Roman History, judges chosen three from each of the thirty-five tribes, so that properly there were 105; but they were called *centumviri*, or the hundred, from the round number. The origin and powers of this court are subjects involved in great obscurity. The principal causes that came under them appear to have been those concerning testaments and inheritances.

Centuriators of Magdeburg. A name assumed by certain Lutheran writers, who, in the middle of the sixteenth century, compiled at Magdeburg a complete history of the Church from the earliest times down to the Reformation. This is the greatest work on ecclesiastical history written on the Protestant side. (Hallam's *Literary History*, part ii. chap. ii.)

Centuries (Lat. centuriæ). In Roman History, the divisions in which the people voted at the Comitia Centuriata. According to the testimony of Livy, they were instituted by Servius Tullius for the purpose of giving to the rich a greater weight in the state. The patricians were represented by six centuries of knights, and twelve centuries of knights were added to these from the plebeians. The rest of the plebeians and clients were divided into five classes, according to the amount of their property; the lower limits of each being respectively 100,000, 75,000, 50,000, 25,000, 12,500 asses. The first of these classes was subdivided into eighty centuries; the next three into twenty each; and the last into thirty. The centuries of each class were again separated into two equal numbers of old and young. By this distribution the preponderance was given to property, though the rich classes were of course outnumbered by the poorer. On the contradictions in the accounts given of the institution of the centuries, see Sir G. C. Lewis, *On the Credibility of Early Roman History*, i. 493 &c.

In the Roman legion, the name Century was applied to the half of the manipulus, or one-thirtieth of a legion.

Centurion (Lat. centurio). An officer in the Roman army, who had the command of a CENTURY [which see]. The word Centurion signifies the commander of 100 men; but this number was in fact seldom complete, as the legion generally fell far short of its full complement. One of the two centurions of each maniple had a precedence before the other: and the centurion of the first century of the first maniple of the Triarians presided over all the others, and had the charge of the eagle or chief standard of the legion, which gave him the privilege of ranking with the knights. The badge of a centurion was a vine rod.

Cephaëlis (Gr. *κεφαλή, a head*). A genus of *Cinchonaceæ*, with the flowers collected in heads surrounded by a leafy involucre, a funnel-shaped corolla, enclosed anthers, and succulent fruit having two compartments, each containing a single seed. *C. Ipecacuanha* is the plant which produces true Ipecacuanha, the emetic properties of which are due to a principle called emetin.

Cephalanthium (Gr. *κεφαλή, the head*, and *ἄνθος, a flower*). A term invented by Richard to express the head or capitate inflorescence of a composite plant.

Cephalaspis (Gr. *κεφαλή, head*, and *ἀσπίς, buckler*). A genus of Placoganoid heterocercal fishes of the Devonian period in which the posterior angles of the shield-shaped helmet that covered the head were produced backwards in a pointed form, giving to the head the appearance of a saddler's knife.

Cephalic (Gr. *κεφαλικός*, from *κεφαλή, the head*). Medicines used for the relief of diseases of the head are frequently termed *cephalic remedies*.

Cephalitis. Inflammation of the brain.

Cephalium (Gr. *κεφαλή*). The peculiar woolly mass formed at the apex of the stem of *Melocactus*, out of which the flowers issue.

Cephalo-thorax (Gr. *κεφαλή, the head*, and *θώραξ, the chest*). The first segment of Arachnidans and Crustaceans, which includes the head and thorax of insects.

Cephalodium (Gr. *κεφαλή*). In Botany, a term used by systematic writers on lichen-

and signifying the figure of a convex shield without an elevated rim; it is called also a tuberculum.

Cephalophora (Gr. κεφαλή, *the head*, and φέρω, *I bear*). A name substituted by De Blainville in his system of Malacology for the 'Cephalopoda' of Cuvier.

Cephalopods or **Cephalopoda** (Gr. κεφαλή, *the head*, and πούς, *the foot*). A class of Molluscous animals having the head situated between the body and the feet; these latter organs consist of a number of fleshy processes, which project forwards from the circumference of the head, and more or less conceal the mouth. The Cephalopods are the first class of *Mollusca* in the system of Cuvier, and the most highly organised of invertebrate animals. They alone present indubitable rudiments of an internal skeleton, developed for the purpose of protecting a brain and lodging organs of sight, and, in most of the existing species, organs of hearing. In these also there are distinct hearts both for the systemic and pulmonary circulations; and highly complicated digestive, secretory, respiratory, and generative organs. The sexes are in distinct individuals. All the species are marine. The principal features of the organisation of this class of Invertebrata are described by Aristotle, and their habits were better understood by that ancient author than by modern naturalists of the present day. The Cephalopods are described and grouped together in the *Historia Animalium*, under the name of 'Malakia.'

Cephaloteæ (Cephalotus, the only genus). A small natural order of Exogens, allied, according to Labillardière, to *Rosaceæ*, according to Brown to *Francoaceæ* and *Crassulaceæ*. Lindley places it in his Ranal alliance, regarding it as a transition to *Francoaceæ* in the Berberal alliance. It consists of a single species, a marsh plant inhabiting New Holland, having pitcher-like bodies mixed with its leaves.

Cepheus (Gr. Κηφεύς). One of the ancient northern constellations, which takes its name from Cepheus, king of Ethiopia, husband of Cassiopeia, and father of Andromeda. It is surrounded by Cassiopeia, Ursa Minor, Draco and Cygnus, and comes on the meridian at midnight in the middle of August.

Cepola (derivation unknown). The name of a genus of spiny-finned fishes, including the common riband-fish (*Cepola rubescens*) of our coasts.

Ceraceus (Lat. cera, *wax*). In Botany, waxy. Applied to the substance of such bodies as have the texture and colour of new wax, as the pollen masses of particular kinds of *Orchis*.

Ceradia (Gr. κέρας, *a horn*). A genus of *Compositæ*, the only species of which is a dwarf fleshy forked stemmed plant, *C. furcata*, found on the island of Ichaboe and the west coast of Africa. The wounded stems exude tears of a gum resin, which has an odour resembling myrrh, and has been called African Bdellium.

Cerambycidæ (Gr. κεράμβυξ). A family of Capricorn beetles, characterised by antennæ generally exceeding the length of the body; a large and distinct labium; strong horny mandibles; maxillæ terminated by two distinct hairy lobes; eyes kidney-shaped, with the antennæ situated in the concavity; body generally long and narrow. The numerous insects of this vegetable-feeding family are arranged in many sub-genera, of which the following are indigenous: *Acanthocinus*, *Aphelocnemia*, *Callidium*, *Cerambyx*, *Clytus*, *Lamia*, *Molorchus*, *Monochamus*, *Obrium*, *Pogonocherus*, *Saperda*, and *Stenopterus*. One of the most remarkable species of our country is the musk-beetle (*Cerambyx moschatus* of Linnæus, *Callichroma* of Latreille), which, when alive, sometimes disseminates an odour resembling that of the otto of roses.

Ceramics (Gr. κεραμικός, from κέραμος, *potter's earth*). A word used in the Arts to express all the varieties of the Potter's trade which have been burnt or roasted in a kiln. These productions are of great beauty and delicacy, and they often display the highest talent of the artist.

Cerasin (Lat. cerasus, Gr. κέρασος, *the cherry*). Cherry-tree gum. A generic name given to those kinds of gum which swell and soften, but do not readily dissolve in water.

Cerastes (Gr. κεράστης, *horned*). The name of a genus of poisonous serpents, characterised by having a pointed recurved horny process standing up over each eye: the horned vipers, as they are termed, are peculiar to Africa.

Cerasus (Lat.; Gr. κέρασος, *cherry-tree*). The genus of *Drupaceæ* (or *Rosaceæ*) which contains the Cherry. Wild cherries are of two kinds, *C. avium* and *C. vulgaris*, and from one or other of these all the fine cherries of our gardens and orchards have been obtained. The genus also contains *C. Padus*, the Bird Cherry; *C. Mahaleb*, of the warmer parts of Europe, whose flowers and leaves are used by perfumers; *C. virginiana*, an American febrifuge; and *C. capricida*, a Nepal species which derives its name from its fatal effects on goats. It is the presence of a minute quantity of hydrocyanic acid which renders so many of these fruits useful for flavouring liqueurs. Both the common Laurel of the gardens and the Portugal Laurel are species of *Cerasus*, the former being called *C. Lauro-cerasus* and the latter *C. lusitanica*.

Cerate (Gr. κηρός, Lat. cera, *wax*). An ointment generally compounded of wax and oil or spermaceti.

Ceratium (Gr. κεράτιον, dim. of κέρας, *a horn*). A one-celled, many-seeded, superior linear fruit, dehiscent by two valves separating from the replum, the seeds attached to two spongy placentæ adhering to the replum, and alternate with the lobes of the stigma. It differs from the siliqua or silique in the lobes of the stigma being alternate with the placenta, not opposite.

Ceratonia. The Carob-tree, or Algaroba, is the *C. Siliqua* of botanists, a small tree of the Leguminous family remarkable for having no corolla to its flower, but a five-parted calyx, five stamens, and a pistil with a sessile stigma. It grows in the countries bordering on the Mediterranean, and its flat pods are called St. John's Bread or Locust-pods, from an assumption that they formed the food of St. John the Baptist in the wilderness. They contain mucilage and saccharine matter, and are used for feeding cattle, for which purpose they have been of late years imported into this country.

Ceratophyllaceæ (Ceratophyllum, the only genus). A small natural order of Exogens, which has been variously referred to *Coniferæ*, to *Haloragaceæ*, and to *Naiadaceæ*. Its affinity, however, appears to be greatest with *Urticaceæ*, of which it may be regarded as a degeneration, having the same incomplete unisexual flowers, monocarpellary ovaries, and solitary ovules, but differing in having an inferior radicle and no albumen. The order consists but of one genus, which is found in the ditches of Europe, being constantly submerged, and floating with its long green leaves after the manner of a *Conferva*. The embryo is decidedly dicotyledonous: otherwise the plant might be referred to *Naiadaceæ*.

Ceratophytes (Gr. κέρας, *a horn*, and φυτόν, *plant*). A name applied by Cuvier to a family of Corticiferous Polyps, comprehending those in which the internal axis resembles horn or wood.

Cerberus (Gr. Κέρβερος). In Mythology, the many-headed dog which guards the entrance of the kingdom of Hades and Persephonê—the fellow-monster being called Orthros. The names of these dogs appear in the Vedic poems under the forms Sarvara and Vritra, the two dogs of Yama.

Cercariæ (Gr. κέρκος, *a tail*). A family of *Infusoria*, having an enlarged body with a slender tail-like appendage. The body of the true *Cercariæ* of vegetable infusores is rounded; that of the zoosperms or animalcules of the seminal secretion is flattened. [ZOOSPERMS.]

Cercopidæ. [CICADELLANS.]

Cercopithecus (Gr. κερκοπίθηκος). The name of the genus of Quadrumanes, including those which have long tails, but not prehensile; or the 'monkeys' of the Old World.

Cere (Lat. cera, *wax*). In Ornithology, the naked and generally coloured skin which covers the base of the bill in some birds, as in those of the hawk tribe. [FALCONIDÆ.]

Cereal Grasses (Lat. ceres, *corn*). Grasses which produce the bread corns; such as wheat, rye, barley, oats, maize, rice, and millet.

Cerebellum (Lat., dim. of cerebrum, *the brain*). The lobe of the brain is so called which is the posterior of the medullary masses composing the brain in vertebrata and underlying the great cerebral mass; its functions have been identified by the majority of physiologists as the seat of coordination of muscular action. As Schiff and Schröder van der Kolk have shown that individuals wanting a cerebellum possess the faculty of coordinating their muscular movements, the doctrine which assigns the muscular centre to the cerebellum may be considered to be disproved, whilst its exact function is yet unknown. Gall described it as the seat of the sexual instinct (amativeness). The opinions, however, of Lockhart Clarke, and the experiments of Combette and Lewes, tend rather to the doctrine that it also possesses a share in sensation, and may possibly even participate in the production of mental phenomena. [BRAIN.]

Cerebral Lobes (cerebrum, *the brain*). The surface of the *cerebrum* in man is divided into three divisions, the anterior, middle, and posterior lobes. The two first are separated from each other by the Sylvian fissure. Between the middle and posterior lobes, however, no definite line of demarcation exists. The third lobe in man covers the posterior third of the *cerebellum*, and extends beyond it. In the inferior Mammalia, the posterior third of the *cerebellum* (at least) is left uncovered, a character differentiating all other animals from man. The cerebral lobes are connected together in the subclasses, *Archencephala*, *Gyrencephala*, and *Lissencephala*, by the structure termed *corpus callosum*, which is functionally absent in the marsupial Mammalia. The lobes are covered by *gyri* or convolutions, which are most numerous and least symmetrical in the brains nearest allied to the human race. [BRAIN.]

Cerebric Acid (Lat. cerebrum, *the brain*). A fatty acid, containing nitrogen and phosphorus, forming one of the components of brain.

Cerebrum (Lat.). The third medullary mass of the brain, counting from behind forwards: it is divided in the mesial line into two lateral lobes or hemispheres, and is the only part of the cerebral organ whose development bears relation to the intelligence of the species. [BRAIN.]

Ceremonial of European Powers. Comprises—1. The particular titles due to sovereigns in different states; the imperial title being considered as expressing some sort of superiority over the royal, and having been in consequence assumed by various kings in their public acts (as the king of England since the union of the crowns). 2. The acknowledgment of sovereign titles, the right to confer which was formerly claimed by the popes as their own prerogative, but which are now assumed by princes, and confirmed by the acknowledgment of other sovereigns. 3. The respective prerogatives of different sovereigns; which species of precedence is that which has occasioned the greatest amount of discussion and dispute when sovereigns, or their representatives, have been brought together. In 1504, Pope Julius II. arranged the rank of European powers in the following order: 1. The Roman emperor; 2. The king of Rome; 3. France; 4. Castile; 5. Aragon; 6. Portugal; 7. England; 8. Sicily; 9. Scotland; 10. Hungary; 11. Navarre; 12. Cyprus; 13. Bohemia; 14. Poland; 15. Denmark; 16. Republic of Venice; 17. Duke of Brittany; 18. Burgundy; 19.

Elector of Bavaria; 20. Saxony; 21. Brandenburg; 22. Archduke of Austria; 23. Duke of Savoy; 24. Grand duke of Florence; 25. Duke of Milan; 26. Elector of Bavaria; 27. Duke of Lorraine. This arrangement, however, gave birth to repeated contests. At present, where precedence is not considered as established between rulers of equal dignity, each concedes to the other precedence at home; and when they meet on the territory of a third party, they take precedence alternately until some arrangement is effected.

Ceremonies, Master of the. An officer of the king's household instituted by James I. for the more honourable reception of ambassadors and strangers of quality. It is his duty to attend and regulate all matters of etiquette in the drawing-room and the levée, and on all occasions where the state of a court is to be maintained.

Cereolite. The name formerly given to Cerolite, and more particularly to the variety found in a violet-red lava in the neighbourhood of Lisbon, where it occurs in rounded grains of a greenish yellow colour.

Cereopsis. The generic name of an Australian goose, characterised by a green cere-like naked membrane covering the upper parts of the base of the bill. It has bred frequently in this country, and there is every probability that it will ultimately become naturalised.

Ceres (Lat.). In Astronomy, one of the four new or telescopic planets which revolve between the orbits of Mars and Jupiter. It was discovered by Piazzi on the 1st of January, 1801. Ceres is a very small planet, its apparent diameter, according to Schroeter, being only 3·48″, which at its mean distance corresponds to about 1,600 miles; but according to Sir W. Herschell its apparent diameter is only 0·35″, or 160 miles. The difficulty of distinguishing its real disc, on account of the nebulosity by which it is surrounded, accounts for the discrepancy. Its mean distance from the sun is about two and three-fourths times the distance of the sun from the earth. [PLANET.]

CERES. In Latin Mythology, the goddess corresponding to the Greek DEMETER [which see].

Cereus (Lat. *waxen*). A large genus of *Cactaceæ*, containing many species of great beauty. *C. giganteus*, a native of the hot arid deserts of New Mexico, grows from fifty to sixty feet high, imparting a singular aspect to the scenery of the country, the tall sparingly branched stems looking like telegraphic posts for signalling from point to point of the rocky mountains which are its home.

Cerin (Lat. cera, *wax*). The portion of wax which dissolves in boiling alcohol. Also a peculiar waxy substance obtained by boiling grated cork in alcohol.

Cerine. The name given by Berzelius to a kind of Allanite which is found crystallised and also in crystalline masses of a brownish-black colour, at Bastnäs in Sweden, associated with Cerite, Hornblende, and Copper Pyrites.

Cerinite (Gr. κηρινός, *waxy*; from its wax-like appearance). A mineral forming the coating or outer portion of a reniform nodule, about half as large as a fist, embedded in crystalline trap-rock near Black Rock in the bay of Fundy, Nova Scotia. [CENTRALLASSITE; CYANOLITE.]

Cerinthians. In Ecclesiastical History, followers of Cerinthus, a heretic of the first or second century, who embraced certain Gnostic views respecting the natures and relations of God the Father and Son. He conceived the supreme God to be the father or originator both of the Deity from whom proceeded the Old Testament, and of Christ; that the God of the Jews was also the creator of this world; and that his dominion over it was superseded by the mission of Christ, who was a son of the supreme Deity residing in a human body. [GNOSTICS.]

Cerinus (Lat. cera, *wax*). In Botany, waxy yellow; a term used in describing colour, to denote a dull yellow with a slight mixture of reddish brown.

Cerio. A term used by Murleel to denote the fruit called a CARYOPSIS [which see].

Cerite. A hydrated disilicate of cerium found in Gneiss, at the copper-mine of Bastnäs, near Riddarhyttan in Sweden. It occurs in short six-sided prisms, also massive and granular, of a colour between dark peach-red and clove-brown, passing into grey; is slightly translucent at the edges, and has a dull adamantine or resinous lustre. It contains also Lanthanum and Didymium [LANTHANOCERITE], and generally a small quantity of Yttria.

Cerium. A metal named after the planet Ceres, and discovered in 1803 by Hisinger and Berzelius in a Swedish mineral termed *cerite*; and since found by Dr. Thomson in *Allanite*, a mineral from Greenland. It is said to be a white brittle metal, very difficult of fusion, and volatile when intensely heated; but we are scarcely acquainted with it in its metallic state. Its equivalent number appears to be 46, on the hydrogen scale.

Ceroleïn. A soft fat contained in bees-wax.

Cerolite. [KEROLITE.]

Ceroma (Gr. κήρωμα). In ancient Architecture, the place where wrestlers were anointed with a mixture of oil and wax.

Ceroplastic (Gr. κηροπλαστικός, *relating to wax-modelling*). The art of modelling in wax; one of very high antiquity. From the testimony of Pliny we learn that Lysistratus, the brother of Lysippus, was the first that used wax for modelling the human figure. He lived in the time of Alexander the Great, and was a native of Sicyon.

Cerosin (Lat. cera, *wax*). A waxy substance which exudes from the sugar-cane.

Cerostrotum or **Cestrotum** (Gr. κερόστρωτος, *inlaid with horn*). A species of encaustic painting chiefly on horn or ivory, with a particular sort of stylum called a CESTRUM [which see]. Doors were sometimes ornamented

with this kind of painting, which seems to have resembled very closely the pyrographic process of the present day with the exception of rubbing in the wax.

Cerotene. A white paraffin-like substance occurring in the distillate of Chinese wax.

Cerotic Acid. A constituent of bees-wax.

Ceroxylon (Gr. κηρός, *wax*, and ξύλον, *wood*). A genus of Palms, one of which, *C. andicola*, is the Wax-Palm of New Grenada. It has a tall stout trunk, bearing a crown of pinnate leaves. The trunk is covered with a thin coating of a whitish waxy substance, highly inflammable, which is collected by cutting down the tree and scraping it. According to Vauquelin, it consists of two parts of resin to one of wax. The wood is hard, and commonly employed for building purposes, and the leaves for thatch.

Certhia (Lat.; Gr. κέρθιος). A genus of Anisodactyle or uneven-toed Tenuirostral or slender-billed Passerine birds, commonly known by the name of Creepers. The common tree-creeper (*Certhia familiaris*, Linn.) is a well-known native species.

Certiorari (Lat.). In Law, is an original writ issuing out of Chancery or the King's Bench, directed to the judges or officers of inferior courts, commanding them to *certify* or return the records of a cause depending before them. By this writ indictments and many other proceedings may be removed from any inferior court of jurisdiction into the King's Bench. It lies generally in all judicial proceedings in which a writ of error does not lie; but not, in common cases, to remove a cause out of an inferior court after verdict.

Cerulin. Indigo which has been dissolved in sulphuric acid.

Cerumen. The secretion which lines the external auditory canal. It consists of albumen, an oily matter, and a bitter colouring matter.

Ceruse, Cerusite or **Cerussite** (Fr. ceruse; Lat. cerussa, *white-lead*). Native carbonate of lead, or white lead-ore. When pure it consists of 16·42 per cent. of carbonic acid and 83·58 oxide of lead; corresponding to 77 per cent. of metallic lead.

It occurs in fibrous, compact, and earthy masses and in numerous crystalline forms which may be referred to a right rhombic prism; also in macles and pseudomorphous forms. When perfectly pure it is colourless and transparent, with an adamantine lustre, which is resinous on fractured surfaces; sometimes the colour passes into grey and greyish-black or it is tinged blue or green by salts of copper. It is very tender and brittle, breaking with a small conchoidal fracture, and is highly double-refractive.

Next to Galena, Cerussite is the most common ore of lead, but it is not often found in sufficient quantity to be of equal importance to the miner. It is of frequent occurrence in lodes, sometimes also in beds in sedimentary limestone, and is almost always associated with Galena, from which it has in most cases originated (Bischof). It is found in Cornwall, Devonshire, Cumberland, Derbyshire, Shropshire, Cardiganshire, Scotland, Ireland, Siberia, Saxony, Bohemia, the Harz, Silesia, Hungary, Carinthia, Westphalia, Monte Pone in Cagliari, North America, &c.

Under the name of *white-lead*, carbonate of lead forms the basis of white oil-paint.

Cervantite. Native tritoxide of antimony, composed of 19·9 per cent. of oxygen, and 80·1 antimony; which occurs in acicular crystals, also massive and as a crust or powder, associated with Grey Antimony-ore, at Cervantes in Spain, and at Pereta in Tuscany. The colour is nearly white, or slightly tinged with yellow, with a greasy, bright, or earthy lustre.

Cervidæ. [DEER.]

Cervinus (Lat. from cervus, *a stag*). In Botany, fawn-coloured.

Cervix (Lat.; literally, *the lower part of the neck*). An obsolete botanical term, superseded by RHIZOMA [which see].

Cessio Bonorum (Lat.). In Civil Law (and in the modern jurisprudence of France, Spain, Holland, and Scotland), a yielding up on the part of an insolvent trader of his estate and effects to creditors, under the authority of the competent court; analogous to the assignment of estate and effects under a fiat in bankruptcy in England. See as to the several regulations respecting the *cessio bonorum* in these different countries, Burge's *Commentaries on Colonial and Foreign Laws* iii. 890 &c.

Cestoideans, Cestoidea (Gr. κεστός, *embroidered*, and εἶδος, *likeness*; *riband-like*). The name of an order of Sterelmintha, or Parenchymatous Entozoa, including those which are commonly called tape-worms.

Cestraceæ (Cestrum, one of the genera). In Botany, a very small group of plants, most usually combined with *Solanaceæ*, but by some botanists separated on account of their straight embryo, foliaceous cotyledons, and valvate corolla. Some of the species have fragrant flowers, especially at night; others emit an unpleasant odour. Some are astringent; others are said to be poisonous.

Cestracion (Gr. κεστραῖος). In Ichthyology, a genus of sharks, characterised by having two kinds of teeth, disposed in oblique subspiral rows; those at the anterior part of the jaws are pointed, and adapted for seizing or grappling shell-fish, &c.; those at the middle and back part of the jaws are flattened for crushing the same: the fishes of this genus are also remarkable for the large spine placed in front of the first dorsal fin. Only two existing species of this genus are known, one of which is called 'the Port Jackson shark.' The fossil remains of Cestracions are numerous.

Cestrotum. A picture made with the CESTRUM [which see].

Cestrum or **Cestron** (Gr. κέστρον). An instrument, also called γραφίς by the Greeks, used by the ancient painters of Greece and Rome in drawing and painting; it was pointed at one end and flat at the other, and was therefore

applicable to both drawing and spreading the colour; it was generally made of metal.

There were three kinds of painting in use among the Greeks and Romans: in two ways with the cestrum, and in a third way with the pencil. This last was used chiefly for decorative work; the colour mixed with wax being burnt into the wood by applying a cauterium to the surface: most surface work was probably executed in this way. The ivory painting with the cestrum (*in ebore cestro*) was more drawing than painting, and seems to have been executed with a hot point; and though not wax painting, was nevertheless encaustic. The second method with the cestrum (*cera cestro*), which was that of Pausias and others, was with the wax colours, which were afterwards *burnt in*. The colours of the ancient painters were commonly called *ceræ*, as being originally, if not always, mixed with wax.

Cestus. [ATHLETES.]

Cestvaen, Cistvaen or **Kistvaen.** A species of stone receptacle often found in barrows (generally at the east end), containing the bodies of the persons buried therein. Cistvaens are commonly formed of three stones, placed on edge, like the three sides of a box, with a stone cover. Some of these monuments, which are styled cistvaens by Sir R. C. Hoare and other antiquaries, are, however, not sepulchral.

Cetaceans, Cetacea (Gr. κῆτος, *a sea-monster*). An order of Mammals living in the sea or large rivers, and shaped like fishes for moving habitually in the watery element, having the posterior part of the spine disencumbered of a sacrum and hinder extremities to allow the tail to have a due freedom and extent of motion. They breathe air, have warm blood, and a double circulation, like the rest of the class to which they belong; they are consequently compelled to resort to the surface for the purpose of respiration; and the tail-fin is accordingly horizontal, and not vertical, as in true fishes.

Cete (Lat.; Gr. κῆτος). The name of the sixth order of Mammalia in the *Systema Naturæ* of Linnæus, containing those marine species which are devoid of hinder extremities. The group corresponds with the carnivorous group of the modern *Cetacea*, the manatee being associated in the Linnæan system with the elephant.

Cetic Acid. The result of the action of alkalies upon *cetine*.

Cetine. Pure spermaceti.

Cetiosaurus (Gr. κῆτος, *whale*, and σαῦρος, *lizard*). A genus of fossil Opisthocœlian Crocodiles, in which the vertebræ exhibit a slightly hollowed cup behind, the forepart being flattened in the dorsal, but produced into a ball in the cervical part of the body. The Cetiosaurians fulfilled the same functions in the Jurassic ages as their analogues the dolphins and whales of the present day.

Cetraria (Lat. cetra, *a buckler*). The genus of lichens which yields Iceland moss. *C. islandica*, the plant to which this name is applied, affords a nutritious article of diet, and a doubtful medicine.

Cetraric Acid. *Cetrarine.* A white bitter acid contained in Iceland moss.

Cetus (Gr. κῆτος, *the whale*). One of Ptolemy's forty-eight constellations, in the southern hemisphere.

Cetyl. The radical of a series of organic bodies. The *hydrated oxide of cetyl* is *ethal*, the base of spermaceti. It combines with negative radicals, forming salts.

Cevadic Acid. An acid contained in the seed of the *sabadilla*.

Cevadilla. [SABADILLA.]

Ceylanite or **Ceylonite.** An iron-and-magnesia Spinel found in rounded grains or small crystals, which are nearly opaque, and of a dark blue or black colour. It is named after the country, Ceylon, where it was first observed in the sand of the rivers. [PLEONASTE.]

Chabasie, Chabasite or **Chabazite** (Gr. χαβάζιος, the name of a stone, mentioned in a poem ascribed to Orpheus). A zeolitic mineral. It is a hydrated silicate of alumina and lime, with small quantities of soda and magnesia, and occurs crystallised in transparent and colourless or greyish obtuse rhombohedrons, which are sometimes pale-red superficially, in certain basaltic and amygdaloidal rocks, or in the geodes of quartz and agate which are disseminated through them. It is found, in Ireland, at Portrush and the Giant's Causeway [PHACOLITE]; in Scotland, at Glen Farg, Eig, and the islands of Mull and Skye; and in Faroe, Iceland, Greenland, Bohemia, Nova Scotia, &c. [ACADIALITE; HAYDENITE; and PHACOLITE.]

Chacone or **Ciacone** (Span.). In Music, a kind of dance resembling a saraband, of Moorish origin. The bass of it consists of four notes, which proceed in conjoint degrees, whereon the harmonies are made with the same burden.

Chaff (A.-Sax. ceaf). The husk or withered calyx of grasses, and more especially of the bread corns. The term is also applied to straw or hay cut into very short lengths, and used for mixing with corn, roots, or other food for horses or cattle. This kind of chaff, in greater lengths, is also used for mixing with mortar on some parts of the Continent, more particularly in Germany and Russia; and it is used as a substitute for hair in making plaster for rooms. Both stubble and cut hay were used by the ancient Egyptians in making bricks.

Chaff of the Receptacle. A term used by some botanists to denote the bracts which are stationed upon the receptacle of Composite flowers, between the florets; they have generally a membranous texture, and no colour, and are usually called Paleæ.

Chaffy. Paleaceous; when a surface is covered with small, weak, erect membranous scales, resembling the chaff of corn, as the receptacle of many Composite plants.

Chailletiaceæ (Chailletia, one of the genera). A natural order of shrubby arborescent

Exogens, placed by De Candolle between *Homaliaceæ* and *Aquilariaceæ*, but referred by Lindley to the Rhamnal alliance, in which it is known by its polypetalous flowers, valvate calyx, stamens alternating with the petals, and pendulous seeds. It agrees with *Homaliaceæ* in the presence of glands round the ovary, but differs in its superior ovary, with the placenta in the axis, and in other characters; and appears to have the closest affinity with *Rhamnaceæ*, with which it agrees in habit. It inhabits the hotter parts of the world, and some species are said to be poisonous.

Chain (Fr. chaîne, Lat. catena). A succession of links, each of which, except the first and the last, joins two others; in buildings, a chain is frequently used with an anchor. The link may be a ring, or a bar of any length with a ring or an eye at each end, or a bar with a hook at one end and an eye at the other; links furnished with eyes are joined by links furnished with hooks, or by keys, pins and wedges. Much depends upon the shape of the links in order to obtain the greatest resistance of a chain; and as long as the strain is kept in the direction of the axis, the strongest form will be obtained when the sides of the chain are parallel to the line of strain. But as this is often in a direction perpendicular to the axis, it is essential to introduce a stay which should maintain the sides invariably in their position, and to resist any unequal compression of the metal in the sides. In the cables used for hoisting building materials, it is not necessary to introduce these stays, because the effort being always one of traction is in the direction of the axis; but in ship cables they are always placed, and they are made of cast iron.

Chain Bond. The name given to a bond course of timber introduced as a part of the construction of masonry, or brickwork, to resist the tendency of those materials to spread laterally under the superincumbent weight.

Chain, Gunter's. The unit of length employed by land surveyors, 100 links = 4 poles = 66 feet = 22 yards. Ten square chains, therefore, are equivalent to an acre. Where land is to be measured for building purposes, a chain 100 feet in length is sometimes used. The object in using such chains is, of course, to facilitate subsequent computations by the introduction of a decimal system.

Chains. On Shipboard, are iron bars or plates bolted strongly through the vessel's sides, and containing in their upper parts the dead-eyes through which the shrouds pass.

Chain-shot. Two cannon-balls connected together by a few links of chain. These balls are used chiefly in Naval warfare. When discharged, they fly apart; and the projectile, revolving necessarily on its shorter axis, mows down any object in the way of the extended chain. The effect upon masts and standing rigging is peculiarly damaging.

Chalaza (Gr. χάλαζα, in the sense of *a knob*). In Botany, the vascular disc caused by the expansion of the vessels of the raphe, upon reaching the base of the nucleus of an ovule, after passing up the side of the latter.

Chalazæ (Gr. χάλαζα, *hail*). A name applied to the two membranous twisted chords attached to near the poles of the yolk of an egg, and serving to maintain it in such a position that the cicatricula shall always be uppermost, and consequently nearest the source of heat during the process of incubation.

Chalcedony. A semi-transparent kind of Quartz which has been apparently produced by the infiltration of water holding silicious matters in solution. It occurs stalactitic, mammillated, and botryoidal, of various colours, but usually milk-white. It is often banded with concentric laminæ of two or more colours, when it is called *Agate*. The red and yellow varieties are called *Carnelian*, and those of a deep brownish red, *Sard*.

The name is after that of the locality (Chalcedon in Asia Minor) where it is said to have been originally found. Fine specimens of Chalcedony are obtained north of Monte Verdi in Tuscany, from the amygdaloids of Iceland, and the Faroe Islands, also from Saxony, Hungary, India, Arabia, Surinam, and Siberia. In the United Kingdom it is found in Cornwall, Devon, and Cumberland; at the Pentland Hills and other places in Scotland; and in Ireland at the Giant's Causeway and elsewhere. Beautiful chalcedonic pebbles may be picked up on the beach at Brighton, on the coast of Sussex between Worthing and Selsey; and fine specimens of botryoidal and stalactitic forms are found lining cavities in flint at Houghton Chalk-pit, near Arundel, in the same county.

Agate, Carnelian, Cat's Eye, Chrysoprase, Flint, Hornstone, Onyx, Plasma, and Sard, are all varieties of Chalcedony.

Chalcedonyx. A variety of Chalcedony, consisting of alternate stripes of white and grey.

Chalcidicum (Lat.). In ancient Architecture, this term was used by Vitruvius to denote a large building, appertaining to some basilicas, and appropriated to the purpose of administering justice. The name is said to be derived from Chalcis, a city in Eubœa.

Chalcodite (Gr. χαλκώδης, *like brass*; from its bronze-like lustre). A mineral, chiefly composed of silica, iron, alumina, and small proportions of alkalies. It is of a greenish bronze or brass-yellow colour, and occurs in minute flexible scales, forming crusts coating Hæmatite, at the Stirling iron-mine near Antwerp, Jefferson county, New York.

Chalcography (Gr. χαλκός, and γράφω, *I write* or *engrave*). The art of engraving on copper or brass.

Chalcolite (Gr. χαλκός, *copper*, and λίθος, *stone*). A variety of Uranite, found in the granite of several Cornish mines near Tavistock; and in Saxony, Bohemia, Belgium, &c. It is a hydrated phosphate of uranium, in which copper takes the place of lime.

Chalcophyllite (Gr. χαλκός, and φύλλον, *a leaf*) or **Copper Mica.** A hydrated ar-

senate of copper occurring in green six-sided tabular crystals which are transparent or translucent, and have a vitreous lustre. It is found in Cornwall near Callington and in Gwennap, and also in Saxony, Hungary, and the Banat. The name is in allusion to the ease with which the crystals may be divided into laminæ.

Chalcotrichite (Gr. χαλκός, *copper*, and θρίξ, *hair*). A fibrous variety of Red Copper-ore, which generally occurs in grouped or reticulated capillary crystals of a crimson or cochineal-red colour. It occurs at Rheinbreitenbach, Moldawa, and Nischne Tagilsk in the Ural. [PLUSH COPPER.]

Chaldron (Fr. chaudron, whence also Cauldron). A measure containing 36 bushels, heaped measure.

Chalilite (Gr. χάλιξ, *gravel*, and λίθος, *stone*). A hydrated silicate of alumina, iron, lime, and soda. It is found in irregular veins of a deep reddish-brown or of a flesh-red colour in the amygdaloid rock of the Sandy Brae district in Antrim, and also at Tudree Hill.

Chalk (A.-Sax. cealc; Lat. calx, *lime*). A form of soft limestone. Chalk is generally of a peculiar white colour, singularly pure chemically, but mixed mechanically with silica either in grains, or in the well-known form of *flints*. This rock is widely spread over Europe. It is common in England, where it forms low hills, ranging from the Yorkshire coast to the coast of Hampshire and the Isle of Wight, with branches to the east coast in Norfolk, and also in Surrey, where both the North and South Downs consist of it. Similar beds cross the German Ocean and the Bristol Channel, and extend for some distance in Denmark and France. The northern extension passes eastward into Poland and South Russia, terminating in the Caucasus. The chalk in France hardens towards the south, and passes into a limestone of ordinary character in the South of France, Switzerland, and Italy.

Chalk seems made up entirely of particles derived from organic matter, and resembles very closely the material brought from the bottom of the Atlantic in deep water. So strong is this resemblance, that it may almost be assumed that the deposit of the original mud that has become chalk was the result of similar causes.

Chalk is highly absorbent, retaining one-third of its bulk of water without difficulty. A cubic foot of wet chalk will contain at least two gallons of water. It is thus very easily injured by frost, and therefore ill adapted for external work in our climate as a building material, but it is useful and has been much employed in the interiors of churches, &c. Chalk being a nearly pure carbonate of lime, makes a lime of extreme purity when burnt. [CHALK-LIME.]

The chalk is rich in fossils, containing a few reptilian remains of great interest, many fishes, and numerous shells and corals, radiata and zoophytes, all of which are more or less characteristic. The fossils of the English chalk have been very carefully described.

Within the chalk, and apparently buried with it, are numerous beds of flint, which is a black and peculiar form of silex. These seem to have been accumulated round organic substances, generally sponges.

Chalk Stones. The concretions formed in the joints of persons who have long suffered from gout were once supposed of a chalky nature, and acquired the above name. They are chiefly composed of uric acid in combination with soda.

Chalk-lime. The lime obtained by the calcination of the upper members of the chalk formation is known amongst builders by the name of chalk-lime, in order to contradistinguish it from the lime obtained from the calcination of the beds of the chalk-marl. The chalk-lime swells very much in slaking; it decrepitates and falls to powder; and is deficient in hydraulic properties; it is a remarkably pure lime—a fact which accounts for its want of hydraulic power, and unless it be mixed with some substance possessing the property of communicating the faculty of hardening to mortars, it will never set when used in large quantities.

Challenge. In Law, an exception to jurors who are returned to serve on a trial. [JURY.]

Chamaceans. In Conchology, the family of Acephalous Lamellibranchiate Molluscs, of which the genus *Chama*, or clam-shells, is the type. The group is characterised among bivalves by having the mantle perforated by three apertures; one for the passage of the foot, another for the respiratory currents, and a third for the escape of the excrements.

Chamælauciaceæ (Chamælaucium, one of the genera). A small order of epigynous Exogens, belonging to the Myrtal alliance, and indeed sometimes regarded as a tribe of *Myrtaceæ*. It is distinguished by having a one-celled ovary, by its few ascending ovules with the embryo fused into a solid mass, and by its dotted leaves and heath-like habit. The order is Australian, and comprises *Genetyllis*, *Verticordia*, *Calytrix*, and a few other genera.

Chamæleon, Chameleon (Gr. χαμαιλέων). A genus of Saurian reptiles with small tubercular scales, and the tail and feet organised for clinging to the branches of trees. The chameleons subsist not on air, as poets feign and the uninformed believe, but on flies and other insects, which are caught by means of a remarkably long and extensible tongue, terminated by a finger-shaped process like the elephant's proboscis, and which the chameleon can dart upon its prey with great rapidity. The rete mucosum, or coloured layer of the skin, contains two kinds of pigment, situated in different layers; the deeper-seated layer is of a deep green or violet-red colour, the superficial pigment is of a greyish colour; the deep-seated pigment is contained in branched cavities, and is movable, producing by its partial accumulation and

varying proportions with the superficial layer the changes of colour for which the chameleon has in all ages been remarkable.

CHAMÆLEON. A constellation near the south pole; it was thus named by Bayer.

Chamæleon Mineral. A compound of manganesic acid and potash, which presents a variety of tints when dissolved in water.

Chamærops (Gr. χαμαίρωψ). The most northern genus of Palms, one of whose species, *C. humilis*, is found in the southern parts of Europe, as far north as Nice. They have a crown of fan-shaped pleated leaves, on stems which vary from three to thirty feet in height. The Chinese *C. Fortunii* proves to be hardy in this country.

Chamber (Fr. chambre, Lat. camera). Properly speaking, this word means a room vaulted or arched, but it is now restricted to mean an apartment appropriated to lodging. With the French the word has a much more extended meaning; but with us, beyond what is above stated, almost the only use of it is that of expressing the room in a palace in which the sovereign receives the subject, which is called the presence chamber; it is usually the most magnificent room in a palace.

Chamber of a Gun. Is a cell or cavity at the bottom of the bore to receive the charge of powder. Mortars, howitzers, shell guns, and rifled breech-loaders, are provided with chambers in our service.

Chamberlain (Fr. chambellan). A high officer in all European courts. Originally the chamberlain was the keeper of the treasure-chamber (camera, in the tenth century); and this meaning of the word is still preserved, in the usages of corporations of London and other places, where the chamberlain is the officer who keeps the money belonging to the municipal body. But, in modern times, the court officer styled chamberlain has the charge of the private apartments of the sovereign or noble to whom he is attached. In England, the lord great chamberlain, or king's chamberlain, is one of the three great officers of the king's household. He has the control of all the officers above stairs, except the precinct of the king's bed-chamber, which is under the government of the groom of the stole. Under him are the vice-chamberlain, lord of the bed-chamber, &c.; the chaplains, officers of the wardrobe, physicians, tradesmen, artisans, and others retained in his majesty's service are in his department, and sworn into office by him. He is commonly one of the highest nobility of the country; in virtue of his situation he precedes dukes. The emblem of office appropriated to the chamberlain in European courts is a gold key, generally suspended from two gold buttons.

The LORD GREAT CHAMBERLAIN OF ENGLAND (not of the household) is the sixth great officer of state. This office belonged for many centuries to the family of De Vere, earls of Oxford; afterward to that of Bertie. In that line it became vested in coheiresses, and is now held jointly by Lord Willoughby d'Eresby and the marquis of Cholmondeley, the former of whom fills the office for the present reign.

Chambre Ardente. In French History, a name given to the tribunal which was instituted by Francis I. for the purpose of trying and burning heretics; and also the extraordinary commissions established under Louis XIV. for the examination of poisoners, and under the regent duke of Orleans for the punishment of public officers charged with certain offences against the revenues, as also of those who were guilty of fraud in the matter of Law's bank.

Chambre des Comptes (Fr. *Chamber of Accounts*). In French History, prior to the Revolution, a great court established for various purposes; as for the registration of edicts, ordinances, letters patent, treaties of peace, &c. The sovereign chambre des comptes was at Paris; there were also inferior courts in ten provincial cities.

Chamfer (Fr. chanfreine). The edge of anything originally right-angled cut aslope or on the bevel, so that the plane then formed shall be inclined at less than a right angle to the other planes which it intersects.

Chamfron or **Champ-frein** (Nor. Fr.). In Plate-armour, plates of steel or pieces of leather, to protect the face of a horse.

Chamoisite. A hydrated silicate of alumina and protoxide of iron, mixed with more or less carbonate of lime, manganese, &c. It is of a dark greenish-grey or blackish colour, and has an earthy appearance with a compact or oolitic structure. It is found in beds of Ammonite-limestone at the mountain of Chamoison, in the Valais.

Chamomile Flowers (Gr. χαμαίμηλον, *earth-apple*). The flower-heads of the *Anthemis nobilis*, or common Chamomile. They are used in medicine in consequence of their bitter extract, which is strengthening, and of their essential oil, which is aromatic and stimulant. The double flowers are much less bitter and aromatic than the single.

Champ de Mars (Fr.). In French History, the public assemblies of the Franks, which were held in the open air, and annually in the month of March; whence the name. Under Pepin and some of his successors they were termed Champs de Mai. An extensive open space in Paris, appropriated to various public solemnities, is termed the Champ de Mars; a name which seems also intended to recall the ancient Campus Martius, or public field of Rome.

Champerty (Fr. champ parti, from Low Lat. campus partitus, *a divided field*). In Law, is a species of maintenance, being a bargain with the plaintiff or defendant in a suit for the 'campi partitio,' or division of the land or thing in dispute between the party, if he prevails at law, and the champerter, on the latter's bearing the expense of the suit. It is a punishable offence both by common law and by statute.

Champignon (Fr.). The name applied by the French to mushrooms in general, but in this country confined to the *Agaricus oreades*,

one of the Fungi, which forms Fairy Rings, and is also one of the most excellent for culinary purposes. It has the great merit of drying admirably.

Champion (from Goth. Kempe). One who fights a public combat, or engages to do so, in his own or another man's quarrel. On the issue in a writ of right, trial by battle might formerly be demanded; and in this case [WAGER OF BATTLE] each party appeared in the field by his champion. The judicial combat in criminal cases might in some countries, although not in England, be fought by a champion for either of the parties if an ecclesiastic, woman, or child. The office of champion of the crown of England is of great antiquity; the manor of Scrivelsby in Lincolnshire having been held from time immemorial in grand serjeantcy, on condition that the lord thereof shall be the king's champion. This manor was long held by the family of Marmion; it passed in the twentieth year of Edward I. to the family of Dymocke, in which it continued until its recent extinction. The champion appeared in Westminster Hall at the coronation, between the courses of the royal banquet, in complete armour; his challenge was proclaimed by the herald, waging battle with any person who should deny or gainsay the title of the king, three times; and the champion threw down his gauntlet. In 1821, at the coronation of George IV., it was decided that this office could be performed by deputy; and Mr. Dymocke being in orders, his place was supplied by his eldest son, Henry Dymocke, who also executed the duty at the coronation of William IV.; but on his decease without male heirs, this ancient office became extinct.

Chance. A term applied to events whose causes are unknown to us. Thus, when a piece of money is tossed up into the air, as no reason can be given why it should fall on one side rather than on the other, it is said to be an even chance which of the sides will turn up. The *Doctrine of Chances* is an important branch of Mathematics. [PROBABILITY.]

Chance-medley (a corruption of the French *chaude mêlée*). In Law, signified originally a casual affray or riot, accompanied with violence, but without deliberation or preconceived malice; but is applied at present to a particular kind of homicide, viz. the killing of another in self-defence in a sudden encounter, without *malice prépense*.

Chancel. The choir of a church between the altar and the lattices (Low Lat. cancelli) or balustrades that surround it, which only ecclesiastics might enter. This is the strict meaning of the word; but in many cases the chancel extends much further into the church, the original divisions having been removed for the greater accommodation of the congregation.

Chancellor (Lat. cancellarius). A high officer in many European states. The cancellarius under the Roman emperors is supposed to have been a notary or scribe, and his title to have been derived from the cancelli or railing behind which he sat. In ecclesiastical matters, every bishop had (and continues to have) his chancellor, the principal judge of his consistory. The chancellor of France began to be an officer of importance under the Frankish kings, especially after the office of referendary had become merged in his, about the ninth century. In 1223 he was made the first minister of the crown, and rank next after the princes of the blood was assigned to him, until the Revolution. The offices of chancellor and keeper of the seals were frequently united. In Germany, the office of arch-chancellor of the empire belonged to the archbishop-elector of Mentz. The archbishop of Cologne was titular arch-chancellor of Italy; the archbishop of Trèves, of Gaul.

In England, the office of chancellor is the most ancient as well as the highest of all judicial offices in the kingdom; for though the superior antiquity of his jurisdiction has been questioned, the establishment of the office itself was certainly prior to the institution of any existing court of justice, the name as well as some of the functions, which were borrowed from the 'cancellarii' of the later Roman emperors, having been introduced into this country within the first three centuries that followed the dissolution of the Western Empire.

In addition to his judicial functions, which are various and extensive, the chancellor is now by virtue of his office privy councillor, and, when a peer, speaker of the House of Lords; over all the members of which, with the exception of the archbishop of Canterbury, he then has precedence in rank. As chief conservator of the peace, he has nomination of all magistrates throughout the kingdom; and he is the patron of all livings of the crown under the value of twenty marks in the king's books. He has also the right of appointment to almost all the offices in the Court of Chancery, and has very great influence over the appointment of the other judges both of common law and equity. He still retains also the title of keeper of the king's conscience, a duty originally incident to his situation in the king's chapel, over the service of which he presided; and this office may perhaps have afforded a ground for that part of his jurisdiction which professes to remedy what is contrary to equity and good conscience. It is further his duty to issue the writs for the convocation of parliament; and all Acts there passed, as well as many records and documents affecting the rights of individuals—as to the latter in order to their validity—are enrolled and kept in chancery, under the immediate care and custody of the Master of the Rolls, himself an officer of that court. The custody of the great seal is the peculiar and essential mark of the chancellor's dignity; and by delivery of that and the proper oaths taken the office is created, with all such of its rights as can be exercised by a chancellor not being a peer.

The jurisdiction of the chancellor is of various sorts. And, first, as to his common law jurisdiction. By this is meant that part of the

chancellor's jurisdiction which is regulated by the same principles, and exercised according to similar forms, with the jurisdiction of the other courts of common law. This is by far the most ancient branch of the chancery judicature, and seems to have been originally incident to the nature of the chancellor's office, whose chief business it once was to advise the sovereign on the subject of grants, charters, and letters patent, and to authenticate them by affixing the great seal after the introduction of that symbol. Out of this naturally arose a jurisdiction in all matters between the crown and its grantees, and the right to repeal or cancel all grants, charters, and letters patent, which should afterwards appear to be contrary to law, or in other respects improperly obtained. In like manner the chancellor had jurisdiction in other matters arising out of commissions under the great seal; such as returns made in pursuance of enquiries under such commissions as to the right of the crown to goods or lands of the subject either by escheat, forfeiture, or any other cause; these were legally called 'offices.'

To the same court also belonged originally, in the time of feudal tenures, jurisdiction in the case of wardship, and some other matters arising out of such tenures between the crown and its tenants in capite; but it should be observed, that as this court had not the power of summoning a jury, it could in no case try an issue of fact. It is called the Court of the Petty Bag, literally from the size of the bag in which its writs are deposited. To the common law department of chancery belongs also the issuing of original writs; that is to say, precepts addressed to the party complained of, stating the nature of the complaint made against him, requiring him to do justice to it, or show cause to the contrary; such writs being originally the first and a necessary step in all causes which were tried before either of the three great courts, or in the 'aula regia' before its division into separate courts.

In this department of his office the chancellor was assisted by officers named Cursitors, whom he was empowered to nominate for that purpose, and upon whom the whole business of devising writs soon devolved. The chancery has hence been called Officina Brevium, or workshop of writs; and is, or was, in respect of the necessity of such writs, the foundation or fountain head of all justice; but this necessity, which had in practice long been satisfied by a fiction, has been in terms dispensed with by the 2nd Wm. IV. c. 39. The receptacle in which these writs were kept was called the Hanaper—literally a basket; and hence the office from which they issued was called the Hanaper Office.

But by far the most extensive as well as most important branch of the chancellor's jurisdiction is the equitable; indeed, it is that branch alone which is commonly meant by the term Chancery. In this department the lord chancellor had until 1813 only the assistance of the Master of the Rolls; in that year a vice-chancellor was appointed; in 1841 two additional vice-chancellors were created; and in 1851 two law-justices of the Court of Appeal were added. Proceedings in chancery are, in practice, commenced before the Master of the Rolls or a vice-chancellor; from their decrees or orders appeal lies to the Court of Appeal in chancery, consisting of the lords justices and lord chancellor, who may sit together with or apart from them; and the final appeal is to the House of Lords.

The general object and character of this equitable jurisdiction is to supply, in civil matters, the deficiencies of the other courts of justice, whether those deficiencies consist in the imperfections of the machinery of those courts, or in their too rigid adherence to peculiar forms, whereby certain classes of rights become excluded from the benefit of their protection. The origin of this equitable jurisdiction is generally sought for in that remnant of judicial power which is alleged to have been left in that part of the 'aula regia' which was not included in either of its subdivisions [King's Bench; Common Pleas], and of which residuary part the chancellor was certainly, since the suppression of the office of justiciary, the principal member, and was thus easily enabled to assume whatever judicial power was left undelegated to the other courts. That such remnant of power was adequate to all purposes to which it was moulded, is inferred from the supreme and comprehensive nature of the 'aula regia' itself, which must be supposed to have been invested originally with full power to do complete and perfect justice, and of which the remnant therefore still retained an undefined measure of authority sufficient to supply what should prove, on experience, to be wanting in the other courts. This view of the subject is strengthened by the fact that the Court of Exchequer, which was not a part of the aula regia, but a collateral and equal court, or rather perhaps the aula regia in a different shape, had also its equitable jurisdiction, in cases in which debtors to the crown were concerned, and, by a convenient fiction, in all cases; as if equity were a necessary part of all complete systems of judicature. Possibly also the idea of paramount and universal authority annexed to the right of framing writs in all actions, or, in other words, of devising remedies for every species of wrong, may have laid the foundation in theory for this supplemental code, as it was certainly the discovery of a new writ, or a new application of an old one, which practically enabled the chancellors to carry their equitable views into effect.

This was the writ of subpœna: a writ returnable in chancery, and calling upon the person to whom it was directed to appeal there, and answer upon oath the complaint that was made against him. The invention of this writ is attributed to John Waltham, bishop of Salisbury, who was chancellor in the reign of Richard II.; and on the power thereby acquired the equitable jurisdiction of the chancery even now rests.

The usual division of the subjects of equitable jurisdiction is into Trust, Fraud, Accident, Agreement, and Account.

As courts of equity take into their consideration a far greater variety of circumstances than do courts of law, and as evidence of no fact not suggested by the pleadings is admissible, the written pleadings are necessarily more copious and important than they are at law: and there is further this most essential difference, that the pleadings on the part of the defendant, i. e. his answer, are upon oath. With regard to evidence the same general rules prevail in equity as in law, as to the admissibility of proofs, the relevancy of facts, and the competency of witnesses, and even the propriety of the questions that may be put; but the manner of taking evidence is different, for with few exceptions, and those as to very simple facts, evidence in equity is taken either under a commission to examine, or by the official examiners in London, and is produced before the court in a written shape, although by some recent statutes a power, rarely used, has been given to examine witnesses *vivâ voce.* Where special applications are made during a cause for something to be done in that cause, or, as may sometimes be done, when applications for an order of the court are made without instituting a suit, the evidence adduced is by affidavit. The hearing of such applications, which is either upon written *petition* or by motion upon written notice, constitutes a great part of the business of the court. Evidence of facts not essential in the first instance to the interposition of the court, is usually taken in the master's office upon a reference made to him. The court, where it appears essential to the interests of justice, will also direct issues of fact to be tried at common law before a judge. The Court of Chancery has also jurisdiction in the guardianship of infants and the management of charities; and the lord chancellor personally has, by special delegation from the crown, jurisdiction in the case of lunatics, which is regulated by statute. [LUNACY.]

The appellate jurisdiction of the chancellor in bankruptcy is stated under BANKRUPTCY.

Chancellor of a Diocese. The keeper of the seals of an archbishop or bishop. This office now includes those of official-principal, whose duty is to hear and decide matters of temporal cognisance determinable in the bishop's court, and vicar-general, who exercises the jurisdiction properly spiritual.

Chancellor of the Exchequer. The highest finance minister of the British government. This office is from its nature necessarily intrusted to a commoner. The chancellor, as an officer of the Court of Exchequer, has precedence above the barons of that court.

Chancellor of a University. The head of the corporate bodies by whom he is elected. He exercises exclusive jurisdiction in all civil actions and suits where a member of the university or privileged person is one of the parties, except in cases where the right to freehold is concerned. The duties of the respective chancellors of Oxford and Cambridge are in nearly all cases discharged by a vice-chancellor.

Change of Seed. In Agriculture, the practice of procuring seed produced in a different soil and climate from that in which it is to be grown as a crop; and which is found to be sometimes beneficial, and sometimes injurious, according as the new seed may have been matured in a better or worse climate and soil than those in which it is to be grown.

Channels. In Nautical language, are projecting wooden platforms jutting out from the ship's sides opposite to the masts. They serve to keep the chains and shrouds distant from the ship's side, preventing thereby chafing against the gunwale, and enabling the shrouds to impart a firmer support to the masts.

Chant (Fr. chanter, Lat. cantare, *to sing*). In Music, an ecclesiastical song usually adapted to the psalms and litanies. There have been several sorts, of which the first was the Ambrosian, invented by St. Ambrose, bishop of Milan. The Gregorian system of chant, which was introduced by Pope Gregory, is still in use in the Romish church. The chants now generally used in Protestant cathedrals and churches have been in some measure derived from the ancient systems, but are more modern in form, and have the agreeable features of tonality, harmony, and rhythm, which were wanting in the earlier modes.

Chantarelle (Fr.). The name of an esculent fungus, *Cantharellus cibarius*, a common inhabitant of our woods, and highly esteemed on the Continent.

Chantonnite. A meteoric mineral, forming compact black veins and angular-shaped masses in the stone which fell at Chantonnay in France.

Chantry. A little chapel, or altar, commonly in some church endowed (before the Reformation) with revenues for the maintenance of a priest to offer masses for the soul of the founder and others; occasionally chantries were, however, distinct buildings. They were dissolved in England by 1 Edward VI. c. 14.

Chapel (Fr. chapelle). In Architecture, a building for religious worship, as in colleges, hospitals, &c. The name is also applied to places of worship subsidiary to parish churches (which are called chapels-of-ease) or belonging to Dissenting congregations. In Roman Catholic cathedrals and churches, those parts of the building which contain the subordinate altars are called chapels. In English cathedrals, the Lady chapel, or chapel of the Virgin Mary, is commonly at the eastern end of the building. In foreign churches the apse containing the altar is frequently surrounded by a number of apsidal chapels.

CHAPEL. In Printing, the junction of the workmen in an office for the purpose of promoting and enforcing order and regularity among themselves, the preservation of the materials, the arrangement of the price of any

doubtful work, and the care of the lights. These objects are accomplished by fines.

Moxon, who published his work on printing in 1683, says, 'every *Printing-house* is, by the custom of time out of mind, called a *chappel*.' It is supposed that the term originated from the circumstance of Caxton, on the introduction of the art into England, practising it in a chapel attached to Westminster Abbey.

The president is termed 'the father of the chapel,' and is elected; the workmen are styled 'members of the chapel;' and this association takes cognisance of all offences, real or imaginary, committed within the office, and punishes the offender by inflicting a fine in proportion to the offence. The process of calling a chapel is by giving the father a halfpenny and desiring him to summon a chapel, stating to him the object; the father then directs the youngest journeyman to announce to all the members the time when it will be held; when the subject is discussed, and the decision taken by vote.

It is an axiom that the chapel is always right; consequently there is no appeal from its decision, and to dispute this would subject the party to its displeasure. It has various ways of enforcing obedience to its dictates.

Chaplain (Low Lat. capellanus). Properly the minister of a chapel. The privilege which the king and nobility enjoy of appointing private chaplains arises from the ancient custom of using domestic chapels for family worship. The limitations under which this privilege may be exercised are set forth in certain statutes of Henry VIII.

Chaplet (Ital. ciappelletto). A string of beads used by Roman Catholics to count the number of their prayers; these prayers consist for the most part of Ave Marias, Paternosters, and Credos. The invention of the practice is generally attributed to St. Dominic. [ROSARY.]

CHAPLET (Fr. chapelet). In Architecture, a moulding carved into beads, olives, and the like.

Chapter (Lat. capitulum; from caput, *head*). The society of canons in a cathedral or collegiate church, of which the dean is the head, which forms the council of the bishop, and in which his election rested before Henry VIII.; from that time the power of the chapter in this particular (in the English church) has become merely nominal. [BISHOP.]

Chapter House. The apartments attached to a collegiate church, or a cathedral, in which the heads of the chapter meet to transact business; they are usually of a very ornamental character, in Gothic or mediæval buildings, as at Salisbury, Wells, Lincoln, &c.

Characeæ (Chara, one of the genera). A natural order of Thallogens entirely destitute of a vascular system, and composed almost exclusively of tubes. The order consists of but two or three genera, which inhabit the fresh and brackish waters of most countries, but are more plentiful in those of the temperate zones. They are remarkable for the distinctness with which the rotation of their fluids may be seen under the microscope. In the opinion of some Italian writers, the insalubrity of the neighbourhood of Rome is owing to the great quantity of *Chara* which inhabits all the pools, and renders them intolerably offensive. The smell which they emit resembles that of sulphuretted hydrogen.

Character (Gr. χαρακτήρ). In the Fine Arts, a distinctive property or mark by which any object is separated from another. In physics as in morals, and also in the fine arts, there are three species of character; Essential, Distinctive or Accidental, and Relative. *Essential character* is that type stamped by Nature on all her works; that great indication observable in the general divisions of the three kingdoms of nature; those distinctions of different classes of beings, of sexes and ages; in short, of all those great external marks which prevent the confusion of one species with another. *Distinctive* or *accidental character* is that dependent on particular circumstances; on all those varieties of developement which a vast number of visible or invisible causes stamp on the same species, according to the difference of their position; as on individuals of the same species, according to the difference of the elements which modify their forms and the influences which some actions may have upon them. *Relative character* is a more particular indication of certain faculties relative to the different properties with which nature has endowed certain species or individuals, in which may be recognised the purposes to which they are more especially destined.

The arts are and indeed can be but the result of the imitation of nature in all countries, of the nations that inhabit them, and of the individuals of which a nation is composed. Nature influences nations, nations men, and men the arts. These are governed either mediately or immediately by an influence more or less dependent on the great natural causes of climate, government, and education, which constitute the essential character of every country; on secondary and political causes, in which nations differ; and on particular causes, which modify individuals. The arts do but imitate this process: according to the particular spot in which they spring up, their imitation embraces either nature in general or parts of nature; either material forms and the sensible images of things, or the moral affections and intellectual ideas of things; but of whatever kind the imitation be, to whatever object it may be directed, the arts are but the faithful mirrors which reflect in every country the physical and moral qualities of nature, of nations, and of the individuals of which the latter are composed. Before judging, therefore, of the imitation, it becomes necessary to judge of the model; and before we can ascertain in what the character of the arts consists, we must know on what its character depends in nature. We have been thus particular in giving some general notions of character, which must be felt before we can be qualified

to judge of the character of the arts in any country. The character peculiar to himself which an artist imparts to his work, and which is called *subjective* by the Germans, is but a modification of the foregoing principles: that distinctive character called *objective*, which a work of art requires that it may seem proper and suitable to its end, may perhaps be more easily understood.

Characters. In Music, the conventional forms in musical writing and printing used for signs of clefs, notes, rests, &c.

Characteristic of a Cubic. Is the invariable anharmonic ratio of the four tangents which can be drawn to a plane cubic from any one of its own points. Since anharmonic ratios are unaltered by projection, no two cubics can be projections of one another unless they have equal characteristics. A classification of cubics according to the nature, real or imaginary, of their characteristics might obviously be made. When the characteristic has the value -1, each set of four tangents forms a harmonic pencil, and the cubic has been called a *harmonic cubic*. When the characteristic has for its value one of the imaginary cube roots of unity, the three fundamental anharmonic ratios of each pencil of tangents are equal to one another and the curve is called an *equi-anharmonic cubic*. (Cremona, *Theoria Geometrica della Curve Piane*, Bologna 1862.) A harmonic cubic is the Hessian of its own Hessian. (Salmon's *Higher Plane Curves*.)

Characteristic of an Envelope. A term introduced into the theory of curved surfaces by Monge (*Application de l'Analyse à la Géométrie*). A surface being regarded as the envelope of another whose form, magnitude, and position vary continuously with the magnitude of a certain parameter, whilst its nature or order remains invariable, the curve in which two immediately successive generating surfaces intersect, and which obviously lies wholly on the envelope, is called the *characteristic* of the latter. Thus if the generating surface be a plane, and its position be allowed to vary continuously, the envelope will be a developable surface whose characteristic is a right line. Again, if the generating surface be a sphere of constant radius whose centre is allowed to describe a given curve in space, the envelope will be a tubular surface whose characteristic is a circle. It is thus obvious that the envelope may be regarded as the locus of its characteristic.

Two consecutive characteristics intersect in points the locus of which forms an *edge of regression* or *cuspidal edge* (*arête de rebroussement*) on the envelope.

If $F(x, y, z, a) = o$, where a is a variable parameter, be the equation of the generating surface, the next succeeding one will have the equation

$$F(x, y, z, a + da) = F + \frac{dF}{da}da = o,$$

and the one immediately following the latter, the equation

$$+ F\frac{dF}{da}\,da + \frac{d^2F}{da^2}\,da^2 = o;$$

so that the equations of a characteristic will be

$$F = o,\ \frac{dF}{da} = o,$$

and a point on the cuspidal edge of the envelope will satisfy the equations

$$F = o,\ \frac{dF}{da} = o,\ \frac{d^2F}{da^2} = o.$$

The elimination of a, therefore, from the first two of these equations will give the equation of the envelope, and its elimination from all three will lead to the two equations of the cuspidal edge of this envelope. The nature of the envelope will of course depend upon the *form* of the function F, as well as upon the *manner* in which the parameter a is involved therein. So long as F remains of the same form with respect to its variables x, y, z, the envelopes are said to belong to the same *family*, and their equations always satisfy one and the same partial differential equation whose order depends upon the manner in which a is involved in F. The connection between the theory of envelopes and the integration of partial differential equations is at once apparent; for further information on this important subject, however, recourse must be had to the works of Monge; Boole, *Differential Equations*; Salmon, *Analyt. Geom. of Three Dimensions*; and others.

Characteristic of a Logarithm. Denotes the positive or negative integer to which a positive decimal, the mantissa, must be *added* in order to obtain the logarithm itself. It is only in common or Briggs's logarithms that any great advantage is gained by thus distinguishing between the integral and decimal parts of a logarithm and by keeping the latter always positive. This convention being made, however, tables of logarithms are much simplified and abbreviated; for the logarithms of all numbers which have the same significant digits, that is to say of all numbers which are obtainable from one another by multiplication by a power of ten, will now have the same mantissa, and the characteristics may be supplied so easily that they need not be recorded. [LOGARITHMS.]

Characteristic of a Plane. [KINEMATICS.]

Charade (Fr.). A species of riddle, the subject of which is a name or a word that is proposed for solution from an enigmatical description of its several syllables taken separately as so many individual words, and then from a similar description of the whole name or word. A charade can only be called complete if the different enigmas which it contains are brought into a proper relation to each other, and, as a whole, unite in an epigrammatic point. The word *charade*, like the term CALEMBOURG [which see], has, it is asserted, been applied to this sort of amusement, from the name of its inventor.

Charadrius (Lat.; Gr. χαραδριός, from their dwelling in χαράδραι, *clefts*). A bird

mentioned by Pliny. The name of a very interesting genus of wading birds, or *Grallatores*, including the British plover and allied species. In modern Ornithology, the Linnæan genus which included the long-legged plover (*Himantopus*), the stone curlew (*Œdicnemus*), and other species is raised to the rank of a family called *Charadriadæ*.

Charcoal. A form of carbon, obtained by burning wood with the imperfect access of air, or by heating or distilling it in iron cylinders so constructed as to allow of the collection of the volatile products; among which are *tar*, and *pyroligneous acid*, which is impure acetic acid. Charcoal, exclusive of its important use as a fuel, is possessed of some curious and valuable properties. It is a very bad conductor of heat; and hence powdered charcoal is used to surround tubes and vessels which are required to retain their heat. It is not injured by air and moisture; hence stakes and piles are superficially charred to preserve them. It is infusible; and provided air be carefully excluded, it undergoes no change in most intense heats. It absorbs air and moisture, and also the colouring and odoriferous parts of many animal and vegetable substances. Tainted flesh and putrid water are thus sweetened by the action of powdered charcoal, especially by what is called *animal charcoal*, obtained by burning bone, or the clippings of hides, leather, &c. Coloured vegetable solutions filtered through well-burnt charcoal are materially decoloured by it. When burned in oxygen or air, it is converted into *carbonic acid*. [DIAMOND and CARBON.] Common charcoal intended merely for fuel is prepared by cutting pieces of wood from 1 in. to 3 in. in diameter into lengths of from 1 ft. to 3 ft., forming them into a conical pile, and covering them with turf or clay; leaving two or three holes, close to the ground, for lighting the wood, and boring through the turf in the upper part of the cone a few other holes for the escape of the smoke. The pile being lighted at the several holes along the bottom, continues burning with a slow smouldering flame for a week or two, and is allowed to cool before the turf is removed. In the case of very high winds, the holes to the windward are stopped, to prevent combustion going on with too great rapidity. Charcoal obtained by distilling beech-wood, dogwood, alder, willow, and other woods which are free from resin, is called *cylinder charcoal*. The charcoal employed in the manufacture of gunpowder is now generally so prepared.

Chards. The footstalks and midrib of artichokes, cardoons, and the white beet are so called. In the case of the artichoke and cardoon, the leaves are tied up, and the light excluded by straw ropes or by soil, in order to blanch the chard, and deprive it of its natural bitterness; after which, when dressed, it becomes an agreeable vegetable. The leaves of the white beet, not being naturally bitter, do not require blanching to render them fit for use.

Charge. In Gunnery, signifies the quantity of powder used at one discharge of a gun. For land service there are certain fixed charges for all guns. These are called service charges. They should be such as to give the greatest initial velocity to the projectile, without unduly straining the gun. For heavy and medium smooth-bored guns, the service charge is one-third, for light smooth-bored guns, one-fourth the weight of the projectile. For firing with hot shot and ricochet firing, these charges are reduced. In the navy, three charges are used, viz. distant, full, and reduced. In rifled guns, also, on account of the absence of windage, the longer time the shot remains in the bore, and the greater consequent strain exerted by the gas, the charges are much less. In Armstrong breech-loading guns, they are one-eighth the weight of the projectile.

CHARGE. In Heraldry, signifies the various bearings, i.e. ordinaries and figures, depicted on the escutcheon. A shield is said to be *charged* with the bearings depicted on it; and so is an ordinary or other charge, when it bears another device upon it.

Chargé d'Affaires. The third or lowest class of foreign ministers, according to the regulations adopted at the congress of Vienna.

Charge and **Overcharge.** In Painting, a term applied to any exaggeration of character, expression from colour, &c.

Charitable Uses. In English Law, purposes of public benefit for which lands might by the indulgence of the law be granted, under certain restrictions, without incurring the illegality of MORTMAIN [which see]. Grants for this purpose are now regulated by 24 Vict. c. 9 (1861). The commissioners under whose superintendence the trusts for this purpose are placed were established under the Charitable Trusts Act, 1853.

Charites (Gr. χάριτες). In Greek Mythology, the Graces. Homer simply speaks of a Charis as the wife of Hephæstus. Hesiod names three, Aglaia, Euphrosynê, and Thalia, as the daughters of Zeus and Eurynomê. With the Greeks these beings were the embodiments of gracefulness and beauty. In the Vedic mythology, the Harits, with whose name that of the Charites has been identified, are the horses of the sun, glittering with dazzling light. But it would probably be a mistake to suppose that the Greeks borrowed from Vedic writings an idea which comes to both Greeks and Hindus from an earlier and common source. The word is traced to the root *ghar* or *har*, to be fat or glittering; the transition from the idea of fatness to that of brilliance and beauty being shown in a large class of words both in Greek and other languages.

Charity, Brothers and Sisters of. In the Roman Catholic church, orders of 'Hospitallers,' established especially in France. Their office is to attend the sick. The females form a similar society to that of the Beguins in Flanders. [BEGUINS.]

Charles's Wain. A name sometimes given by astronomical writers to the constellation Ursa Major, or Great Bear. It has sometimes also been applied to the Little Bear. For the origin of the names of these constellations, see Max Müller, *Lectures on the Science of Language*, 2nd Series, p. 361 &c.

Charlock (also called Kedlock: A.-Sax. cedeleac). A common name for two of our most common agricultural weeds, *Sinapis arvensis* and *Raphanus Raphanistrum*. The plants when young are remarkably like those of mustard or of the common turnip; but they are easily distinguished by the taste, which is hot and bitter, while that of the turnip is mild.

Charon (Gr.). In Mythology, the ferryman who conducted the souls of the departed in a boat across the Stygian lake to receive judgment from Æacus, Rhadamanthus, and Minos, the judges of the infernal regions. He received an obolus from every passenger, for which reason that piece of money was placed in the mouths of the dead. He was said to be the son of Erebus and Night.

Charring of Posts. The practice of carbonising by burning that portion of the surface of wooden posts which is to be inserted in the ground. The object is to prevent the posts from decaying, more especially at the surface of the ground, or, as the common phrase is, between wind and water. The practice is common in most parts of Europe, and even in Russia and Sweden, though timber is there so abundant.

Chart (Lat. charta, *paper*). A hydrographic map for the use of navigators, being a projection of some part of the sea or coast on a plane surface. Charts as well as ordinary maps may be constructed on any of the principles by which a spherical surface is represented on a plane; Mercator's projection, however, which will be hereafter explained, is the one generally used.

Charta, Magna (Lat.). In English History. The 'Great Charter of the Realm' was signed by King John in 1215, and confirmed by his successor Henry III. It is reported to have been chiefly drawn up by the earl of Pembroke and Stephen Langton, archbishop of Canterbury. Its most important articles are those which provide that no freeman shall be taken or imprisoned or proceeded against, 'except by the lawful judgment of his peers or by the law of the land,' and that no scutage or aid should be imposed in the kingdom (except certain feudal dues from tenants of the crown) unless by the common council of the kingdom. The remaining and greater part of it is directed against abuses of the king's power as feudal superior.

Chartaceus (Lat.). Papery; indicating the paper-like texture and substance of most leaves.

Charte. In French History, originally used to indicate the rights and privileges granted by the French kings to various towns and communities; but applied at present to the fundamental law of the French monarchy, as established on the restoration of Louis XVIII. in 1814. The *Charte* consists of sixty-nine articles, and is founded on principles analogous to those of the British constitution, as embodied originally in the Magna Charta and subsequently extended in the Bill of Rights. As is well known, it was the violation of an article of the *Charte* by the ministers of Charles X. that led to the revolution of 1830, the expulsion of that monarch from the throne, and the establishment of Louis Philippe's dynasty, which, after eighteen years' sway, was itself expelled, February 24, 1848, and therewith the Charte which it was called in to support fell to the ground.

Charter-party. In Mercantile Law, is defined to be a contract, by which the owner or master of a ship hires or lets the whole or a principal part of it to a freighter for the conveyance of goods, under certain specified conditions, on a determined voyage to one or more places. A charter-party is generally under seal; but a printed or written instrument signed by the parties, called a memorandum of a charter-party, is binding if no charter-party be executed. A voyage may be performed in part under a charter-party, and in part under a parol agreement; but the terms of a charter-party cannot be altered by parol evidence, although they may be explained by mercantile usage. The instrument expresses the freight to be paid, and generally, but not necessarily, the burden of the ship; together with some usual covenants, and others at the discretion of the parties.

Chartists. The name assumed by a certain political party in England, composed chiefly of the working classes, who have embodied their principles in a document called the 'People's Charter,' the six leading points of which are universal suffrage, vote by ballot, annual parliaments, electoral districts, abolition of property qualification, and payment of members of parliament.

Chartulary. In Diplomatics, a collection of the charters belonging to a church or religious house.

Charybdis (Lat.; Gr. χάρυβδις). In Mythology. [Scylla.]

Chaschisch. [Assassins.]

Chase. Is part of a gun in front of the trunnions. In smooth-bored cast-iron guns it is the part between the second reinforce ring and the neck of the piece. [Gun.]

Chase. In Forestry and rural matters, a row or rank of plants or trees, and more especially of hedge plants; also an extent of waste or forest land. The name is applied in England to some of those uncultivated lands which were set apart for the breeding of deer and other large game for hunting—as Waltham Chase, Cranborne Chase, Cannock Chase. Most of these, however, are no longer used for this purpose.

Chase. In Nautical language, pursuit; also the vessel pursued.

CHASE (Fr. chassis). In Printing, an iron frame three-fifths of an inch in thickness, in which the pages of type are wedged up to secure the letters from separating or dropping out in the process of printing. Chases are of different dimensions, according to the number of pages in a sheet, and the size of the paper: in the printing of books there are two bars fixed across at right angles, called crosses, so as to divide the chase into quarters for greater security. The thickness is always the same, however large may be the chase, being lower than the types, for the purpose of keeping the margin of the paper clean.

Chaser. The vessel pursuing. Also guns at the head and stern for firing when in chase.

Chasing or **Enchasing.** In Sculpture, the art of embossing or making bassi rilievi in metals. The work is punched out from the back, and then cut on steel blocks or puncheons, and cleared with small chisels and gravers.

Much chasing is done by filling the vessel to be chased with a composition of pitch, and then hammering with a point and chisel on the outside.

Chat-potatoes. Small potatoes, only fit for giving to pigs or boiling for poultry.

Chat-wood. Small sticks and spray, only fit for fuel.

Chathamite. A variety of Cloanthite found in Mica-slate at Chatham, Connecticut. It is chiefly an arsenide of nickel and iron containing 1·3 per cent. of cobalt.

Chatoyant (Fr.). In Mineralogy, the changeable light, resembling that observable in the eye of a cat, reflected by certain minerals. The reflections are sometimes coloured, as in Labrador Felspar; or pearly, as in Adularia; or silky, as in the fibrous variety of Gypsum called Satin Spar.

Chavica. A genus of *Piperaceæ*, separated from *Piper*, from which it differs in its perfectly unisexual flowers, which are sessile on spikes placed opposite the leaves. It yields some few important species, as *C. Roxburghii* and *C. officinarum*, which furnish the Long Pepper of commerce; and *C. Betel* and *C. Siriboa*, which furnish the Betel Pepper chewed by the natives of the Eastern Archipelago.

Chaya Root. The root of the *Oldenlandia umbellata*, cultivated upon the Coromandel coast as a red dye stuff.

Cheese. The curd of milk compressed into solid masses of different sizes and shapes; and, when intended for keeping, salted and dried, and sometimes coloured and flavoured. It is generally made from the milk of cows, but occasionally from that of ewes, and sometimes from the milk of goats. The following are the principal British cheeses: *Brickbat*, formed of new milk and cream, chiefly in Wiltshire, in the autumn, and sold in little square pieces about the size of brickbats. *Cheddar*, round thick cheeses, weighing from 100 or 200 pounds, solid, white, and homogeneous, and of the very best quality. *Cheshire*, large round thick cheeses, commonly weighing from 100 to 200 pounds each; homogeneous, and friable rather than viscid. They are made, like the Cheddar, from the whole of the milk and cream; the morning's milk being mixed with that of the preceding evening, previously warmed. *Derbyshire* is a smaller white rich cheese. *Dunlop*, originally made in Ayrshire, but now general throughout Scotland, is large, round, white, buttery, and weighs from 30 to 60 pounds. This and the Derbyshire cheese are very much alike in form, colour, and flavour. *Gloucester*, large, round, and mild; buttery rather than friable. There are two kinds, the single and double Gloucester; the single differs from the double merely in being half its thickness. *Green* or *Sage* cheese may be made of any of the other kinds by mixing the milk before it has curdled with a decoction of sage leaves, among which some put a few flowers of marigold and leaves of parsley. In the Highlands of Scotland the leaves or seeds of lovage are added to the sage, and communicate a very strong flavour. *Lincolnshire* is made of new milk and cream; it is quite soft, not above 2 inches thick, and will not keep more than two or three months. *Norfolk*, the weight is generally from 30 to 50 pounds; the curd is dyed yellow with arnotto or saffron; and though not a rich cheese, it is considered a good keeper. *Soft* or *Slip-coat* is a small soft rich cheese, which might almost be mistaken for butter, if it were not white; it must be eaten in a week or two after making. *Stilton*, so named from the town in Huntingdonshire where it was first brought into notice, but which is made principally in Leicestershire. It is rich, buttery, and white; and, unlike all the other cheeses which have been mentioned, it is twice as high as it is broad. It is much improved by keeping. It is the dearest of all English cheeses, the price being generally to that of Cheshire as 2 to 1, or 2 to 1½. In order to induce premature decay and the consequent appearance of age in these cheeses, it is said the makers sometimes bury them in masses of fermenting straw. *Cottenham*, so named from a town in Cambridgeshire; it differs chiefly from the cream cheese of Stilton in being flat, broader, and superiorly flavoured. The flavour is said to be owing to the rich grasses which grow on the Fens. *Suffolk*, or *Skim-milk*, is round and thin, weighing from 25 to 30 pounds each, and is the best keeping cheese made in England. *Wiltshire* resembles the Cheddar and Cheshire cheeses, but is of inferior flavour. *Yorkshire* or *Cream cheese* is the same as the slip-coat cheese already mentioned.

Foreign Cheeses.—The most remarkable of these are the following: *Parmesan* is chiefly made at Parma and other places in Lombardy, of the curd of skimmed milk hardened by heat. Its flavour is said to be owing to the rich pastures of that part of Italy, where plants, from the greater quantity of bright sunshine than in Britain, have doubtless their aromatic properties increased. *Swiss cheese* is of various kinds; but the chief sorts are the Gruyère or Jura cheese, and Schabzieger or green cheese;

the last is flavoured with the seeds and leaves of the melilot, and is made, as its name imports, chiefly of a mixture of sheep's and goat's milk. *German cheeses* are of different kinds; but none are celebrated, unless we except that of Westphalia, which is made up into round balls or short cylinders, under a pound weight each. The flavour which this cheese acquires arises from the curd being allowed to become partially putrid before it is compressed. In Holland very good cheese is made, particularly the Edam and Gouda cheeses; the former is very salt, and keeps well at sea. In many parts of the Continent, and even in the interior of Poland and Russia, there are imitations of English cheese made; but what may be called the indigenous cheese of the Russian empire is nothing more than salted curd put into a bag and powerfully pressed, and taken to market as soon as it is made, in the same manner as butter is. In some places, instead of a press, the whey is forced out of the curd by putting it into a long cloth midway between the two ends, while a person at each end twists the cloth in an opposite direction, and thus wrings out the whey. In some Russian villages the curd is exposed for sale in small lumps, retaining the marks of the fingers, which shows that no other pressure has been employed than what can be given with the hand.

In France the Roquefort cheese is the most esteemed, and next that of Neufchatel. The former somewhat resembles Stilton, but is much inferior; and the latter is a cream cheese, seldom exceeding a quarter of a pound in weight.

Cheese-room. The common name in some parts of England for the Horse-mushroom, *Agaricus arvensis*, a species which grows in rings, and is largely gathered for market.

Cheetah or **Cheeta.** A Mahratta vernacular name, applied both to the *Felis jubata* and the *Felis Leopardus*. It is to the former species, or hunting leopard, that the term is confined in this country.

Cheilognatha (Gr. χεῖλος, *a lip*, and γνάθος, *a jaw*). An order of Myriapods or Centipedes, of which the lower lip is formed by the tongue and two mandibles.

Cheilopoda (Gr. χεῖλος, and πούς, *a foot*). A family of Myriapods, in which a pair of feet form the lower lip.

Cheiromys (χείρ, *hand*, and μῦς, *mouse*). A genus of Strepsirhine Quadrumana, peculiar to Madagascar. The Chieromys [AYE-AYE] was discovered by the French voyager Sonnerat, since whose time no specimens had been brought to Europe. Professor Owen succeeded in obtaining a specimen from the Hon. H. Sandwith, which he dissected in 1863. Cuvier had placed it amongst the Rodents, misled by the appearance of the incisor teeth; but an examination of the brain leaves no doubt of its quadrumanous nature. The foreleg turns freely in the prone and supine positions; it is pentadactyle; the innermost digit stands out at an acute angle with the index, and is opposable to the other digits, making a prehensile hand, but in a less perfect degree than in the Old-World or 'catarrhine' quadrumana. The second, fourth, and fifth digits have the ordinary thickness, the fourth being almost twice the length of the second. The third or middle finger is singularly attenuated; is rather shorter than the fourth digit; and is terminated by a slender curved claw. It is this seemingly atrophied digit which the Aye-aye inserts into the burrows of the wood-boring caterpillars, after it has gnawed down to and exposed them by its strong foreteeth, in order to extract the grub. The hind limb is longer than the fore limb, and is terminated by a more perfect hand; the 'hallex' or thumb being stronger, and set at a more open angle with the other toes, which are more like each other in length and thickness. The thumb has a flat, broad nail. From the external characters of the Aye-aye it might be inferred that it was of arboreal habits, the limbs being constructed chiefly for grasping, especially the hinder pair, as in all good climbers. The circular open eye, large iris, and wide pupil, reducible to a minute point when contracted, indicate a climber of nocturnal habits. The large and perfect ears bespeak the acuteness of their sense. The tail, long and bushy, but not prehensile, may add to the protective non-conducting covering of the well-clothed body during sleep. In a variety of particulars, its nearest approach is to members of the Lemurine group. In ordinary zoological or external characters, Professor Owen considered that its nearest allies were certain Galagos of Africa (*Otolicnus crassicaudatus* and *Otol. Alleni*).

Cheironectes (Gr. χείρ, *hand*, and νήχω, *I swim*). A genus of spine-finned fishes, having the pectoral fins supported, like short feet, upon peduncles. By means of this organisation the cheironects can creep over the mud or sand when left dry by the receding tide; they also propel themselves along by short leaps, and in this way seize upon insects which may be hovering about; whence they have obtained the name of frog-fishes. The gill-cavity is large, but the outlet very small, and the quantity of water which can thus be retained enables the cheironects to remain out of water longer than fishes in general can do. The term *Cheironectes* is applied by Illiger to a genus of opossum having the hinder hands webbed. Some naturalists adopt this application of the term, and apply to the genus of fishes so called by Cuvier the name *Antennarius*, originally given to the cheironects by Commerson.

Cheiroptera (Gr. χείρ, *a hand*, and πτερόν, *a wing*). An order of Mammalia, characterised by having the anterior extremities, and especially the hands, so modified as to serve the office of wings, the fingers being extremely lengthened, and connected together by a thin membrane. Of this order the common bat (*Vespertilio pipistrellus*) may be regarded as the type. The order includes very numerous and diversified species, which have been grouped by De Blainville, who has devoted an especial

study to them, into three principal divisions. Of these the *first* includes the largest species, called 'flying-foxes' (*Pteropus*): they are, however, vegetable-feeders, and are characterised by having the ears and nose of a simple form; the two innermost fingers of the hand armed with claws, and of the ordinary structure; the tail, and the web of skin connecting the hind-legs, and called the 'interfemoral' web, very short, or wanting; and lastly, by having the molar teeth separated by intervals, and of simple structure. These bats are distributed over the warmer latitudes of the old continent, and extend to the islands of the Pacific Ocean. The *second* division has the nose complicated by variously shaped and grotesque membranous foliations; the first or innermost digit alone retains its ordinary structure and armature; the molar teeth are beset with sharp tubercles; and the food of these species consists of insects, or the blood of higher organised and larger animals. The vampire-bats of South America belong to this group, which also includes the horse-shoe bats (*Rhinolophi*) and other genera distributed over all parts of the Old World. The *third* division of *Cheiroptera* has the nose constantly simple: the other characters as in the second. It includes the bats properly so called (*Vespertilio*), which are uniformly insectivorous, and of small size.

Cheirotherium (Gr. χείρ, *hand*, and θηρίον, *beast*). This name was given by Kaup to a mammalian animal, supposed to have produced the handlike impressions on the Triassic sandstones of Hildburghausen and Lancashire. These have since been demonstrated to belong to a batrachoïd reptile, the LABYRINTHODON.

Chelæ (Lat.; Gr. χηλαί, *claws*). The first pair of forcipated extremities of the crab, lobster, and other crustaceans.

Chelicercs (Gr. χηλαί, and κέρας, *a horn*). The term applied by Latreille to two appendages of the head of the Arachnidans, or spiders and scorpions, which appendages he considers as representing the mesial antennæ of the *Decapod Crustacea*, here converted into manducatory organs.

Chelidonic Acid. A white crystalline acid contained in the common *celandine* (*Chelidonium majus*). It forms definite salts with bases.

Chelidonine. A bitter alkaloid contained in the celandine.

Chelidonium (Gr. χελιδόνιον, *celandine*). A genus of *Papaveraceæ* found plentifully in a wild state in the neighbourhood of villages and old ruins in this country. The common Celandine, *C. majus*, has pinnately lobed leaves, and small yellow flowers succeeded by siliquiform pods, and is full of an acrid yellow milk, which is used to destroy warts.

Chelmsfordite. A crystallised greyish-white mineral composed of silicate of alumina and silicate of lime, found at Chelmsford in Massachusetts. It appears to have the same composition as Meionite and Scapolite.

Chelonians, Chelonia (Gr. χελώνη, *a tortoise*). The order of Reptiles, including the tortoises, terrapenes, and turtles; characterised by the body being enclosed between a double shield or shell, out of which extend the head, tail, and four extremities. The land tortoises have the power of retracting all these parts within the shell.

Chemical Nomenclature. The early chemists distinguished the compounds which they discovered, by general names to indicate their source, and special names to indicate their appearance; thus—*horn silver, butter of antimony, oil of vitriol, spirit of salt.* The elements were named in an equally loose manner. The latter names have, in some cases, been retained, while the former have been almost wholly replaced by a system of names indicating as far as possible the composition and constitution of the compounds.

When a compound contains only two elements, its name is composed of their names, one of which is abbreviated, and the terminal *ide* attached. Thus a substance containing chlorine and sodium is called chlor*ide* of sodium. So ox*ide* of iron (oxygen and iron), sulph*ide* of antimony (sulphur and antimony), &c.; the name of the more negative element being always the one thus altered. When acids whose names end in *ic* combine with bases, the name of the resulting salt is composed of the names of its constituents, but the *ic* is dropped and the terminal *ate* substituted. Thus, carbon*ic* acid and soda form carbon*ate* of soda; nitr*ic* acid and potash form nitr*ate* of potash; and so on. So acids whose names end in *ous*, form salts the names of which end in *ite*. Thus, nitr*ous* acid and ammonia form nitr*ite* of ammonia. Sulphur*ous* acid forms sulph*ites*, the *ur* being omitted for sake of euphony. The difference in the terminals *ic* and *ous* attached to the name of an element indicates its state of oxidation. For example, sulphur and oxygen combine in the proportion of one atom to three, and one to two; the former is called sulphur*ic* acid, the latter sulphur*ous* acid, *ic* always indicating a higher state of oxidation than *ous*. The abbreviated and slightly altered Latin and Greek numerals *mono, bi* or *bin, ter, quadr, quin*; and *prot* or *proto, di* or *din, tri* or *tris, tetra*, and *penta*, indicate one, two, three, four, or five, &c. atoms of the substance to whose names they are affixed, the Latin most frequently referring to the negative constituent, the Greek to the positive. Thus *di*iniodide of copper is a compound containing two atoms of copper to one of iodine. Biniodide of mercury would indicate two of iodine to one of mercury. *Teracetate* of lead contains three atoms of acet*ic* acid to one of oxide of lead; *tris*-acetate of lead contains one of acetic acid to three of oxide of lead. *Sub* indicates an under or lower or smaller quantity of the substance to whose name it is attached. *Per* is another general rather than special prefix, having the opposite signification to that of *sub*. *Sesqui* indicates *one and a half* atoms of any element

or compound whose name it is associated with. Inasmuch, however, as half atoms are not supposed to exist, *sesqui* always indicates three atoms of the element to whose name it is affixed, united with two atoms of the second body forming the compound. Thus *sesqui*chloride of iron contains three of chlorine to two of iron, not one and a half of chlorine to one of iron.

The above method of carrying out the principle of naming chemical compounds so as to indicate their composition and constitution, does not, however, meet the requirements of the chemists of the present day, as it can only to a limited extent be applied in describing chemical compounds of organic origin. The large numbers of atoms of each of the few elements which are associated in an organic molecule, precludes the idea of so naming the compound as to indicate mere composition, while expression of constitution is in most cases out of the question, simply because we are ignorant of it. Where anything is known of constitution, the same method of nomenclature is applied, but the frequent result is an almost unpronounceably long name. Moreover, views of chemical constitution being generally based on theory, all constitutional systems of nomenclature become modified and altered with the progress of science, and the result is the extreme inconvenience of having two or three names for one substance.

A congress of chemists held at Carlsruhe in the year 1860 discussed the question how best to put the language of chemistry into harmony with the actual state of the science. The conclusion arrived at was that there was at present insufficient ground for a general agreement on this subject, and that individual liberty was indispensable to progress.

Chemin des Rondes (Fr.). In Fortification, a passage left between the top of the revetment of the escarp and the parapet itself, so constructed that the defenders, themselves protected, can fire from it into the ditch.

Chemistry or **Chymistry** (the latter way of spelling this word implies the certainty that the *y* represents the Greek *υ*, and that the word is derived from the Greek χυμός, ἡ χυμικὴ being thus *the science of juices*, i. e. of *fusion*. This is, to say the least, very doubtful. Humboldt (*Cosmos* ii. 528) decides against it. The Greek forms χημεία and χημευτικὴ have been referred by some to *Chemi*, the name of the ancient Egyptians: this derivation, if proved, would make Chemistry *the Science of the Egyptians*: Niebuhr, *Lectures on Ancient History* i. 46).

Chemistry is a department of science, the objects of which are to investigate the nature and properties of the elements of matter, and their mutual actions and combinations; to ascertain the proportions in which they unite, and the modes of separating them when united; and to enquire into the laws and powers which preside over and affect these agencies. As an *art*, chemistry may be traced to a very remote period; but it can scarcely be said to have existed as a *science* previous to the commencement of the seventeenth century: and in tracing its early history we shall find the principal materials upon which it is founded in the works of Bacon, Boyle, Hooke, Mayow, and Newton.

As *induction from experiment* is the exclusive basis of chemical science, little progress could be made in it till the futility of the ancient philosophical systems had been exposed, and their influence annihilated, and till the necessity of that form of severe experimental enquiry had been established which 'first procures the light, and then shows the way by its means.' Upon such foundations, laid by Bacon, the other philosophers whose names have been mentioned proceeded to bring together and arrange the materials which had been furnished by their predecessors, and were thence led into that train of true philosophical reasoning and research which roused the emulation of their immediate successors, and which has led in our times to the gigantic results of modern discovery.

It is well known that the alchemists had accumulated a number of valuable but isolated chemical facts, and that they had explored with considerable diligence the abstract properties and mutual agencies and relations of the greater number of natural products; but, with few exceptions, they neglected their useful and obvious applications, and wasted their labours upon unattainable and chimerical projects. Their discoveries and inventions, as Lord Bacon justly and forcibly observes, 'are well represented in the fable of the old man who left an estate to his children, buried, as he said, in his vineyard, which therefore they fell to dig and search for with great diligence; whereby, though they found no gold in substance, yet they received an abundant vintage for their labour. So assuredly has the search and stir to make gold produced a great number of fruitful experiments.'

Alchemical speculations, including the attempts at the conversion of mercury into gold, and the search after antidotes and universal remedies, were vigorously carried on during the sixteenth and seventeenth centuries; and many amusing accounts of the professors and adepts of those periods have been handed down to us by the chemical historians of the time. Those who are curious upon these subjects may consult Mangetus, *Bibliotheca Chemica*, and the *Theatrum Chemicum* of Elias Ashmole: the latter contains 'several poeticall pieces of our famous English philosophers, who have written the hermetique mysteries in their owne ancient language,' but their perusal is labour lost; not so, however, with Basil Valentine, Paracelsus, Van Helmont, and Glauber, in whose writings we not only find the materials so happily worked upon by Hooke and Mayow, but which also abound in announcements of important practical discoveries, and in hints to which many of the improvements of modern times may be plausibly traced.

Basil Valentine of Erfurt was born about the year 1400; his writings, although tinctured

with the follies of alchemy, are full of shrewd and intelligent remarks: he was the discoverer, apparently, of nitric and of sulphuric acid, and of many antimonial preparations, which are fully described in his *Triumphal Chariot.* Philip Hochener, more commonly known under the name of Paracelsus, and who died in 1541 at Salzburg, in the forty-third year of his age, is chiefly celebrated for the boldness and assiduity with which he introduced chemical preparations into the practice of medicine; he did little, however, as a discoverer. Van Helmont, one of the soundest writers of his period, was the first who seems to have paid attention to the nature of gaseous bodies, and to the distinction between permanent gases and vapours: the word *gas* first occurs in his works; and under the term *gas silvestre*, he seems to allude to what was afterwards termed *fixed air.* None, however, of these early practical chemists come into competition with Glauber. He was an active experimentalist and an acute reasoner; and among his discoveries we may enumerate the distillation of muriatic acid from a mixture of sulphuric acid and common salt; the purification of the residuary sulphate of soda, which he termed *sal mirabile*, and which still bears his name; the production of ammonia by the distillation of bone, and its conversion into *sal ammoniac* by the addition of *spirit of salt*; the preparation of sulphate of ammonia, which he terms *secret sal ammoniac*; the formation of blue vitriol by the action of sulphuric acid upon the green rust of copper; the composition of numerous earthy, alkaline, and metallic salts; and lastly, the evolution of vinegar during the destructive distillation of wood, for which he describes and delineates the distillatory apparatus, under the name of 'a press for extracting the juice of wood,' and the uses of which, together with those of the oil of tar and other products, he describes at length, closing his discourse with a statement of his apprehension that he shall be by many disbelieved: but 'it contenteth me,' he says, 'that I have written the truth, and lighted a candle to my neighbours.' Glauber also published a pamphlet, entitled, *The Consolation of Navigators; in which is taught how they who travel by sea may preserve themselves from hunger and thirst, and also from those diseases which are wont to happen in long voyages: written for the health, comfort, and solace of all those who travel by water for the good of their country.* The sensible plan of employing extract of malt as a portable vegetable diet, and diluted muriatic acid to quench thirst, is here recommended; and many of the medicinal uses of that acid are dwelt upon, among which are some that have been claimed as recent discoveries. On the whole, there is no author, contemporary with Glauber, who has written so much to the purpose, and who, as it were, anticipated so many of our modern scientific improvements.

Reverting to the names of Boyle and his eminent associates, we are reminded of the origin of the *Royal Society of London for the Improvement of Natural Knowledge*, which was incorporated by Charles II. in the year 1662, and of which Boyle and Hooke were active and distinguished members. Boyle died in 1691. His station in life, his mild and prepossessing disposition, his strict honour and integrity, and the unaffected earnestness with which he promoted experimental enquiry tended to shed a lustre on his pursuits, to elevate their character with the world, and to draw into their precincts many who without such an example would have passed their lives in that listless inactivity then too common with those upon whom fortune smiled: among these Mr. Boyle made many converts.

Boyle's Essays on the Successfulness and Unsuccessfulness of Experiments, and the Preface to his Philosophical Writings, are in the genuine spirit of experimental research; but the new and important aspect assumed about this time by such pursuits is perhaps chiefly due to Dr. Robert Hooke (born in the Isle of Wight in 1635, and died in London in 1702). Among his views and discoveries which bear upon the progress of chemical philosophy, the most important are those relating to the phenomena of combustion, and to the part which the air performs in that process; his notions upon these subjects are remarkable for their boldness as differing from the prevailing theories of the day, and for their correctness as superseding the objections to which those theories were liable. From the hints contained in the writings of the alchemists, it appears that the phenomena of combustion were referred to a subtle and highly volatile principle, which, agitated and expanded by heat, produced *flame* and *fire*. When metals were exposed to the action of heat, the greater number of them were observed to alter their appearance, and losing their brilliancy, became converted into an earth-like powder or *calx*. It was generally admitted that in this process the particles of the combustible were thrown into violent vibrations, and in that way transformed into heat and light. But it had been also remarked that in certain cases of combustion, and especially as regards the metals, the phenomenon was attended by an actual increase of weight in the burning body, and that this result was incompatible with the theory which assumed the conversion of the combustible into heat and light, or the evolution of that principle of inflammability which by Becher and Stahl and the chemists of that school was termed *phlogiston*. About the year 1630 a remarkable tract appeared in France relating to this subject, by Jean Rey, a physician of Perigord. Le Brun had melted two pounds six ounces of lead, and found that in six hours the whole had been converted into calx; but that instead of having lost *phlogiston*, or any other ponderable matter, it had actually increased in weight to the extent of some ounces. Puzzled by this result, he consulted Rey as to its cause, who immediately undertook an experimental en-

quiry, which led him to refer the increase in weight in this and similar cases to the *fixation of air*. This inference was amply supported by the researches of Boyle and of Hooke: the former found that no combustible would burn under the exhausted receiver of the *air-pump*, and consequently that the presence of air was requisite; and Hooke, finding that however intensely charcoal was heated, it would not burn when air was excluded, infers 'that air is the universal dissolvent of inflammable bodies, and that this dissolution generates heat, which we call *fire*.' But he went a step beyond this, and attributes the power of supporting combustion to a principle in the atmosphere, 'like unto, or the very same as that which is fixed in saltpetre;' for he had observed the power of that salt as a supporter of combustion. His words are as follow: 'The dissolving parts of the air are but few, and hence the atmosphere is like those spirits which have much phlegm mixed with them, and become soon glutted; whereas saltpetre abounds more in those solvent particles, and hence a little will dissolve a great sulphurous body quickly and violently; and as other solvents, though but weak, quickly consume the dissoluble body if the supply be renovated, so air applied to a shining body by bellows will dissolve it as rapidly as saltpetre.' From all which he concludes that there is no element of fire, but that flame results from the mutual chemical action of the combustible upon a part of the atmosphere. (Hooke's *Micrographia*.) Hooke also alludes to the part performed by *air* in the process of respiration; and in his *Lampas*, published in 1677, has given a beautiful explanation of the burning of a candle. He attributes the light and heat to the action of the air upon the combustible matter of the flame, and shows that the interior of the flame is not luminous, by the simple expedient of viewing its section through a thin piece of glass or of mica.

These doctrines of Hooke were further illustrated by John Mayow (born in Cornwall, 1645; died in London, 1679), who not only experimentally corroborated them, but pointed out the connection between combustion and respiration, and showed that that part of the air concerned in the support of flame was also essential to the life of animals. He placed a candle under a bell-glass, and when it would no longer burn, he found that on rekindling it, it was immediately extinguished by the same air; he then placed a mouse in a confined portion of air, and it soon manifested the want of its renewal; he then put the mouse under the same bell-glass with the candle, and found that it only lived half the time that it had survived without the candle; he then reversed the experiment, and endeavoured to burn a candle in air which had been breathed, and finding that it went out, he concluded that the 'nitro-aërial particles' of the air were as essential to respiration as to combustion, and that they were in both cases *absorbed*; and he even refers *animal heat* to the influence of the air upon the blood.

But Mayow's claim to a distinguished place in the history of chemistry is not merely founded upon the sagacity with which he followed up these views; he was the first who distinctly expounded the nature of *chemical affinity*, and who taught its independence of those mechanical forms of the particles of matter to which it had been referred, and showed, contrary to the prevailing tenets, that in cases of combination the particles of the acting bodies were not annihilated, but that they still existed in the compound, and might again be elicited from it, with all their former powers and properties. These notions he illustrates by a series of extremely apposite experiments; and proceeds to explain *decomposition* upon the principle of inequality in the respective attractive forces of the acting bodies, a doctrine which was afterwards verified and further explained by Newton, whose masterly sketch of a theory of chemical attraction, given in the queries to the third book of Optics, is nearly in the language and entirely in the spirit of his predecessor. The theory of combustion and of affinity, thus established upon the basis of experiment by Hooke and Mayow, constitute the foundation upon which most of the superstructure of modern chemistry rests; the former was extended and embellished by Lavoisier, and the latter has gradually risen into the atomic and equivalent doctrine. There are three principal points connected with the vast extension and importance of chemical science as we now find it, which it becomes necessary therefore to notice; namely, the investigations relating to the philosophy of *heat*, those connected with *pneumatic chemistry*, and those establishing the connection of *electrical* with *chemical* phenomena.

It was not till towards the middle of the seventeenth century that such perfection was given to the construction of the *thermometer* as to enable it to be used as an accurate and comparative measure of temperature. Dr. Halley seems to have been the first who applied the uniform temperature of boiling water to obtain one fixed point for its graduation; the constant temperature of water in the act of freezing seems also to have been noticed about the same time by the Florentine academicians, and by Newton; and these two points being thus determined and ascertained, together with the causes of their occasional discrepancies, the graduation of the thermometer became easy, especially when the advantages of mercury had been pointed out by Halley, together with the mode of sealing it in the thermometer tube. [THERMOMETER.] But the great and important step in the philosophy of heat was the consequence of Dr. Black's discovery of the state in which heat exists in liquids and vapours, and upon which he founded his theory of *latent heat*. This theory gave a satisfactory solution of a multitude of natural and artificial phenomena previously unexplained or unobserved, and laid the foundation of those wonderful improvements in the theoretical

and practical construction of the steam-engine which were soon afterwards carried into effect by Watt.

Dr. Black was born in 1728 on the banks of the Garonne, and was educated at Belfast, and afterwards at Glasgow: in 1766 he was appointed to the chemical chair in the university of Edinburgh, where he died in 1799. He not only made the grand discovery of the latency of heat, but he enriched chemistry with other discoveries; among which that of the presence of carbonic acid in the mild earths and alkalies, and the cause of their causticity, was especially perfect and important. These facts, including also the discovery of carbonic acid, or, as it was then called, *fixed air*, were first published in 1756; his ideas respecting the combinations of heat with ponderable matter were perfected in 1764.

Another and distinct series of enquiries, having important bearings upon the philosophy of heat, had their origin with the Florentine academicians towards the end of the seventeenth century, and were afterwards sagaciously followed up by Scheele, Leslie, and others; they relate to the *phenomena of radiation*, to the manner in which heat is propagated through space, to those of its emanation from luminous and incandescent bodies, and to its connection with light.

Pneumatic Chemistry had its origin in the experiments of Hooke and Mayow, and was subsequently extended by Hales, and more especially by Priestley. Mayow obtained hydrogen gas by the action of iron on dilute sulphuric acid, and observed the formation of nitrous gas during the action of aquafortis upon the same metal; but it was not till the commencement of the last century that the distinctive characters of the gases and their importance as chemical agents began to be duly appreciated. Connected also with this subject is the rise and progress of the chemical physiology of vegetation. Dr. Stephen Hales was born in Kent in 1677, and died at Teddington in 1761. He began the communication of his researches to the Royal Society in 1717, and in 1727 published his *Statical Essays, containing an essay towards a natural history of vegetation, of use to those who are curious in the culture and improvement of gardening; also a specimen of an attempt to analyse the air by a great variety of chemico-statical experiments, which were read at several meetings before the Royal Society.* In 1733 a second volume of these essays was published, containing *Hæmastatics, and experiments on the stone of the kidney and bladder.* In his various experimental researches detailed in these essays, Dr. Hales describes many curious facts, and shows much ingenuity in the contrivance of apparatus; but he furnishes a striking instance of the facility with which the mind is led away from the true path of discovery by preconceived opinions; for having predetermined that the various gaseous products which he obtained were mere modifications and contaminations of common air, he missed much that was fairly within his grasp. He observed, for instance, that air was absorbed during the combustion of phosphorus in close vessels, but he examined none of the products; he collected the air evolved during the destructive distillation of wood, and found it fatal to animals; from Newcastle coal he obtained one-third of its weight of gas; and from nitre, 180 times its bulk; but he did not leisurely examine any of these products. He found that iron filings and oil of vitriol would not evolve gas unless water was present; but instead of stopping to examine the properties of the hydrogen gas which he thus obtained, he hastens on to irrelevant observations, being more eager to multiply experiments than to examine their results. In the same way he details with minute accuracy the quantity of air generated during the distillation of blood, tallow, sal ammoniac, and many other substances, without drawing a single useful inference. In his experiments on respiration, too, he obtained results of extreme interest, and is often upon the verge of most important discoveries; but instead of being incited by the novelty of his results, and the extent of the field of investigation opened by his researches, he drops them upon the occurrence of the slightest difficulty. His examination, however, of the motion of the sap in vegetables was pursued upon a more regular and satisfactory plan; he ascertained the quantity of matter imbibed and perspired by several plants and trees; the proportion daily lost by the leaves, and their influence upon the absorptive powers of the root; and the relation of various states of the atmosphere as to temperature and moisture upon these functions. He endeavoured to confer different flavours upon fruits by impregnating the soil with perfumed water, and he found that the odorous particles were rejected by the living vessels, but that they affected the dead parts of the tree; he compares the functions of the leaves of evergreens with those of deciduous shrubs and trees; he notices the effect of cutting a ring of bark off the branch of a tree in promoting the growth of its leaves and fruit; and, lastly, shows that air is sometimes absorbed or inspired by plants, and gives some interesting views relative to the germination of seeds.

When it is recollected that Hales wrote at the commencement of the last century, that few models of good scientific composition were then extant, and that a pompous and obscure style was prevalent among many of his contemporaries, we must admire the perspicuous and unadorned manner in which he details his facts and observations. He has in this respect all the merit which belongs to Boyle without his diffusiveness; and a pleasing vein of sound and unaffected morality accompanies his arguments, and leads him, whilst endeavouring to unveil the mysteries of nature, to direct our attention with becoming modesty to the extreme penury of man's wisdom, when compared with the admirable adjustments of causes and effects discoverable in the lowliest works of the Creator.

But although Mayow, Hooke, and Hales had done much towards establishing the interest and importance of gaseous chemistry, it is to Dr. Joseph Priestley (born at Fieldhead, near Leeds, 1733; died in Pennsylvania, 1804) that we owe the principal progress in this branch of science. He directed his attention to it with a degree of activity and skill then peculiarly his own, and in the number of his discoveries left his contemporaries far behind, while he certainly rivalled them in their interest and importance, which is the more surprising when we reflect that he generally seems to have considered his philosophical studies as subordinate to his more severe and serious occupations. He first turned his attention to chemistry about the year 1768. He used to amuse himself with experiments on fixed air and on artificial mineral waters; and one experiment, as he says, leading to another, he soon collected those materials which he laid before the Royal Society in 1772, under the title of *Observations on Different Kinds of Air.* It was on the 1st of August, 1774, that he made the great discovery upon which so much of the subsequent progress of chemical science has depended, namely, that of *oxygen gas.* He obtained it by exposing a quantity of *red precipitate of mercury* to the action of the sun's rays concentrated upon it by a lens; the red precipitate was contained in a flask filled up with mercury, and inverted in a basin containing the same metal. 'I presently found,' he says, 'that by means of this lens air was expelled from it very readily. Having got several times as much as the bulk of my materials, I admitted water to it, and found that it was not imbibed by it; but what surprised me more than I can well express, was that a candle burned in this air with a remarkably vigorous flame, very much like that enlarged flame with which a candle burns in nitrous air exposed to iron or liver of sulphur; but, as I got nothing like this remarkable appearance from any kind of air besides this particular modification of nitrous air, and I knew no nitrous acid was used in the preparation of *mercurius calcinatus,* I was utterly at a loss how to account for it.' He then goes on to show that *red lead* and *nitre* also afford oxygen at a red heat, and calls it, consistently with the theory of combustion which was then prevalent, *dephlogisticated air,* regarding it as common air deprived of phlogiston, and consequently possessed of a powerful affinity for that imaginary principle.

Shortly after the discovery of oxygen, Priestley ascertained that plants had the power of purifying air which had been vitiated by the respiration of animals, and that oxygen was evolved by aquatic plants in water containing carbonic acid. Nitrous and nitric oxide, muriatic acid, and ammonia were also amongst his gaseous discoveries. In 1772 Dr. Rutherford had demonstrated that a large portion of the atmosphere consisted of a peculiar gas differing from fixed air, yet like it extinguishing flame and unfit for respiration; to this component part of the atmosphere Dr. Priestley gave the name of *phlogisticated air,* and pointed out the means of ascertaining its relative proportion to the oxygen of the air by the agency of nitrous gas.

Another celebrated name connected with the progress of this department of chemical science is that of Cavendish (born in London, 1731; died at Clapham in 1816). In 1776 he presented the Royal Society with a dissertation on inflammable, fixed, and nitrous air. The two latter gases had been well described by his contemporaries: but nothing very precise was known respecting inflammable air, till its sources and properties were described in Cavendish's paper. He found that it was the lightest known substance, and showed that by combining with oxygen, *water* was the only result; hence the term *hydrogen* subsequently applied to this gas. Cavendish also discovered the composition of nitric acid; and by passing a succession of electric sparks through common air, and through artificial mixtures of oxygen and nitrogen, he succeeded in effecting their combination, and in producing that acid.

Two capital and extremely important steps were thus made in chemical science, chiefly by the joint labours of Priestley and of Cavendish; namely, the composition of the atmosphere and of water; and about the same time Scheele (born at Stralsund in 1742, and died at Köping, near Stockholm, in 1786), in his dissertation on manganese, made known the existence of chlorine, or, as he then termed it, of dephlogisticated muriatic acid gas. His *Observations and Experiments on Air and Fire* and on *Heat and Light,* are also masterly productions, and contributed, in conjunction with the labours of his eminent contemporaries, to invest chemistry with a degree of interest and importance which gave it an entirely new and distinct aspect.

It was at this period that Lavoisier (born in Paris in 1743, where he fell a victim to the Revolution, May 8, 1794) and his associates in Paris undertook that celebrated reform of chemical nomenclature which ended in the banishment of phlogiston, and introduced a logical precision into the precincts of chemistry. Lavoisier experimented upon a magnificent scale, and with a degree of statical accuracy which stamped his researches with a new and valuable character. By a series of beautiful experiments he determined the relative proportions of the elements of the atmosphere and of those of water; he rejected all supporters of combustion except oxygen, and regarded it as the great source of the heat and light evolved during that process; he endeavoured to prove that gases were constituted by the union of ponderable bases with *caloric,* or the *matter of heat,* and examined, upon a splendid scale and with magnificent apparatus, the results of the combustion of sulphur, phosphorus, carbon, and the metals; he inferred that oxygen was the universal *acidifying* principle; and by a series of well-conceived researches he demonstrated the

identity of charcoal and the diamond, and showed that when burnt in oxygen they yielded carbonic acid gas. Lavoisier was also the first who examined with requisite accuracy the products of the distillation of animal and vegetable substances; he also enquired with more success than any of his predecessors into the phenomena of fermentation, and, by examining the contents of certain vegetable juices, previous to and after that process, he drew some curious and important conclusions respecting the changes that take place: he also extended and corroborated Scheele's views as to the importance of the chemical agencies of light.

These and a variety of other details are embodied in Lavoisier's *Éléments de Chimie*, which appeared at Paris in 1789; a work which eminently displays the extent and perspicuity of his views as a theoretical and experimental philosopher, and which contains a masterly refutation of the phlogistic doctrines. The abstract facts, however, upon which this refutation rests, may be traced to Mayow, Hooke, Priestley, and Scheele. It has been stated that the prominent features of the French theory were its explanation of the phenomena of combustion and of acidification, the presence of oxygen being deemed essential in both cases. That air is the food of fire was known at a very remote period: that it causes the increase of weight sustained by metals during their calcination was shown by Rey early in the seventeenth century; that a part only of the atmosphere, identical with a matter contained in saltpetre, is concerned in the support of flame, was explained by Hooke in 1667; and that the vital, or igneous spirit, as he terms it, contributes to the formation of acids, was asserted by Mayow in 1674. Here, therefore, without even infringing upon the eighteenth century, we have, in explicit detail, the principal facts and arguments requisite for the construction of the French theory; and if to these we add the discovery of oxygen by Priestley, and of the composition of water and of nitric acid by Cavendish, what then becomes of its title to originality?

The influence of the researches connected with the philosophy of heat, and of those relating to the production, properties, and constitution of the gases, upon the improvement and extension of chemistry, will now be apparent; but one of the most fertile sources of its recent progress is of a distinct and remarkable origin, namely, the discovery of *the chemical influences of electricity*.

In 1790 Galvani of Bologna ascertained that certain spasmodic or convulsive contractions might be produced by the action of electricity upon the nerves of a recently killed animal; and that if the sciatic nerve of a frog be laid bare and touched with a piece of zinc, whilst at the same time the muscle is touched with gold, similar effects to those of electricity are produced whenever the metals are brought into contact, or connected by conductors of electricity; if non-conductors were used, no spasm ensued. He accounted for these and similar effects by assuming that the nerves and muscles were in opposite electrical states, and that the spasms were the consequence of their annihilation or discharge.

Volta, on the other hand, finding that two different metals were essential, referred the phenomena to the electromotive power of the metals; and, following up this idea, he soon succeeded in producing that extraordinary form of electro-generative apparatus which is now known under the name of the Voltaic pile or battery, consisting of alternations of two metals with an intervening fluid. Zinc, copper, and diluted acids were the substances generally resorted to. It has since been shown by Faraday that *chemical action* is the exclusive source of the electricity of these Voltaic arrangements; but their history and the theory of their phenomena will be given elsewhere.

In the year 1800 the *chemical powers* of the Voltaic pile were first observed in regard to the decomposition of water and certain saline solutions, by Messrs. Nicholson and Carlisle; these were more accurately investigated in 1803 by Hisinger and Berzelius, and in 1806 Davy communicated his celebrated lecture, *On some Chemical Agencies of Electricity*, to the Royal Society. He had previously (1801) given a paper to the society containing an account of some galvanic combinations formed by the arrangement of single metallic plates and fluids, analogous to the galvanic apparatus of Volta; but it was not till the publication of the Bakerian Lecture above referred to that the importance of *electro-chemical science* could be appreciated. It contains a masterly outline of the subject; and its details present a fine specimen of experimental enquiry, especially in reference to the manner in which he traces out the decomposing powers of an electrical current in effecting the separation of the elements of water; the skill with which the conflicting results of other experimentalists are examined and explained; the caution with which he proceeds from experiment to theory; and the sagacity with which he employs theoretical views as the source of new experimental enquiries. The path which he had thus opened for himself, led him on to the most important and extraordinary results, among which were the decomposition of the alkalies and earths, and the discovery of an entirely new class of metals.

But the eradication of established errors is perhaps a more difficult task than the promulgation of new theories; and in this Davy rendered a memorable service to chemistry by his several papers on *Oxymuriatic Acid*, in which he successfully establishes the views of Scheele regarding its nature, and refutes and subverts those of the French school, which had been sanctioned by the chemists of Europe: he demonstrates the existence of acids without oxygen, and lays the foundation of the theory of the *hydracids*.

To these masterly researches Davy added a third series, also of considerable importance:

those relating to the *safety lamp*. His first paper upon this subject is printed in the *Philosophical Transactions* for 1815, and was followed by four others. When he found that flame would not recede through tubes of very small diameter, the idea occurred to him of constructing a lamp which should have no connection with the surrounding air except by such tubes; and he inferred from previous experiments that such a lamp might safely be employed in coal mines infested by fire-damp. He then endeavoured to ascertain the extent to which the tubes might be *shortened* without interfering with this principle of safety, and was thus led to cut them down, till their transverse section resembled a series of meshes. This approached so closely to *wire-gauze* that he was induced to try how far that tissue would prevent the passage of flame; and finding it effectual, he employed it in the construction of his lamp, and ultimately adopted the simple and efficient arrangement now in general and successful use. During the experimental investigations upon which the discovery of the safety lamp was founded, Davy ascertained a number of curious facts respecting the constitution and temperature of flame, which, with other parts of his general enquiry, are not less ingenious than original. In November 1820, Sir H. Davy became president of the Royal Society, and continued to contribute papers as heretofore, some of them upon subjects of much interest, ably and philosophically discussed: among them the essays on the modes of protecting the copper sheathing of ships deserve especial notice; they have furnished hints for the preservation of iron and other corrodible metals from the influence of air and water, and have led to results of great practical importance. In the course of the year 1827 his health became seriously impaired; he passed the greater part of the year 1828 in Italy, and terminated his memorable existence at Geneva in May 1829, in the fifty-second year of his age.

We have now briefly sketched the principal circumstances in the history of chemistry bearing upon its origin and progress as a science, without, however, adverting to the labours of contemporaries; it remains to add a short notice respecting the art of *Analysis*, and the important consequences of which the prosecution of that branch of the science has been productive.

Analysis was first scientifically pursued by Bergman of Sweden. He was born in 1735, and died in 1784, in consequence, as is said, of too intense application to his studies. The use of *tests* for the discovery of certain substances held in aqueous and other solutions, is first particularly dwelt upon by Boyle. He used vegetable colours for the detection of acids and alkalies, and noticed the cloudiness produced by nitrate of silver in a solution of common salt. In 1667 Du Clos undertook an examination of the mineral waters of France; and in 1686 Hierne published some clever experiments upon the same subject in Sweden. In 1726 Boulduc used spirit of wine to precipitate the salts insoluble in that menstruum; in 1755 Venel pointed out the existence of fixed air in the waters of Selters, Spa, and Pyrmont; Lane, in 1769, showed the method of imitating chalybeate springs; and in 1772 Priestley published directions for saturating water with fixed air. The above and other tests were particularly examined, their accuracy compared, and the best modes of applying them pointed out, by Bergman: his dissertations on the waters of Upsal, on sea-water, and on the artificial preparation of medicated waters, each exhibit proofs of his skill as an analyst, and accuracy as an experimenter. He also turned his attention to the analysis of minerals; his essay, entitled *De Minerarum Docimasiâ Humidâ*, must be considered as the parent source of that branch of analytic chemistry so successfully followed up, though upon a limited scale, by Scheele, and in the improvement and extension of which Klaproth passed his long and laborious life. Klaproth was born at Wernigerode in Prussia in 1743, and died at Berlin in 1817. He published 207 essays, in his *Contributions towards the Chemical Knowledge of Mineral Substances.* Another eminent name among chemical analysts is that of Vauquelin, who died at an advanced age in Paris in 1829. He was originally a peasant boy in Normandy, and afterwards was employed in Fourcroy's laboratory, where he not only acquired great dexterity in the ordinary duties of his situation, but became an expert and original analyst. He afterwards rose to high eminence in his profession; and his numerous and important contributions and discoveries are lasting monuments of his skill and industry.

Among the improvers of analytical chemistry in this country, Chenevix, Howard, and Tennant deserve particular mention; but to none is this part of the science more deeply indebted than to Dr. Wollaston. With him and Davy all that is practically useful in the theory of definite proportionals, or, as it is often called, the *Atomic Theory*, may be said to have originated; though the facts upon which it is founded were chiefly furnished by the German analysts, and by Higgins of Dublin.

We have in another place given some account of this important subject, and have endeavoured to explain the facts upon which it is founded, and the results to which it leads: its promulgation with us is mainly attributable to Wollaston's suggestions contained in his paper *On a Synoptic Scale of Chemical Equivalents*, brought before the Royal Society in November 1813. Many years previously he had established the important doctrine of multiple proportions, in a paper *On Superacid and Subacid Salts*. He now showed the practical applications of which the theory was susceptible; and, by connecting the scale of equivalents with Gunter's sliding rule, has put into the hands of the chemist an instrument infinite in its uses, and equally essential to the student, the adept, and the manufacturer.

There remains to be noticed a distinct branch of chemistry of extreme interest and importance, but beset with peculiar difficulties; namely, that relating to *organic substances*. Some progress was made in it by Scheele, but it has chiefly been enriched by the labours of modern and contemporary philosophers, and in their hands has assumed an entirely new aspect. The composition of organic bodies may be viewed in two ways; either as relates to their ultimate elements, or to their proximate groups. The former are remarkably few in number, and are almost exclusively confined to four; namely, carbon, hydrogen, oxygen, and nitrogen. These, by their varied and extraordinary union, give rise to innumerable secondary products, or proximate principles. That the same elementary forms of matter should give rise to such infinitely varied products, merely in consequence of the varying proportions in which they are combined and the circumstances under which they have been presented to each other; that food and poisons, alkalies and acids, sweets and bitters, and, in short, the most opposite and dissimilar qualities, should arise out of such causes—is extremely remarkable; and although every day is adding to our information, and clearing difficulties from this department of chemistry, it is but in its infant state.

In looking at the present state of chemistry, it must be allowed that it exhibits a most promising aspect: the study of its abstract principles is calculated to keep the curiosity constantly on the alert, and awaken an intense and peculiar interest; and it is quite impossible to glance at its recent progress, and at the extraordinary discoveries which are daily rewarding the labours of its skilful cultivators, without anticipating most important consequences. Should its future progress only equal that of the past, it must lead to results deeply affecting the interests and welfare of mankind; but as it has hitherto acquired strength with its progress, its wonders may be expected to accumulate in a much higher ratio. We already seem to be on the brink of some great discovery connected with those powers and properties of matter which we call *electrical*. Their association with, and convertibility as it were into, heat, light, and magnetism, and their identity with the cause of chemical affinity, have already been turned to great account; and it is only necessary to assume the possession of a more unlimited command than we at present enjoy over the production or evolution of this extraordinary agent, less dependent and scanty means of summoning it into existence or activity, and a more intimate acquaintance with its forms and qualities, to confer the highest interest upon our speculations. Its chemical powers would then be perpetually called into action as a substitute for the more sluggish or circuitous and difficult methods of ordinary decomposition. Its single application to the evolution of oxygen and hydrogen from water would alone work wonders; whilst the facility of its conveyance and transmission, its ubiquity, and its varied attributes in those different states which for want of more explicit knowledge of their cause have been termed *quantity* and *tension*, seem to point it out as of unlimited application to human uses. Through its instrumentality telegraphic communication has not only been accelerated, but rendered independent of weather, and equally easy by night as by day; and even in the present state of this invention, there seems no reason against such conveyance of our thoughts, wants, and wishes, so as to transmit them over the globe with a rapidity as much beyond all previous experience, as the travelling on a railroad exceeds that of a common carriage.

Connected, therefore, with the progress of the higher departments of chemical science, and indeed intimately interwoven with it, is the advancement of its application to all the arts of life. It is often supposed that the successful applications of chemistry to the arts have been rather the results of accident or chance than the consequence of those apparently abstract studies, and curious rather than useful discoveries, as they are called, in which the truly philosophical chemist is engaged, and in which his labours terminate; but experience justifies no such conclusion. There can be no doubt that Black's researches into those effects of heat which are connected with changes in the state and form of bodies, and especially with the constitution of vapour, led Watt into that train of reasoning by which his improvements in the steam-engine were ultimately effected. Many of the wonders of modern chemistry must be referred to Galvani's experiments on a dead frog. They led Volta to the construction of the electric pile; and, in the hands of Davy and his successors, what important conquests have been attained, and what extraordinary consequences are daily flowing from a source so apparently unpromising and irrelevant! Independent of the new agents which have been placed in the hands of the experimentalist, and of the new and important theoretical considerations which arise out of them, the whole aspect and character of a great department of physical science has been wonderfully changed, extended, and improved; the cause of magnetism has been developed; and a power no less extraordinary and applicable to human uses than light and heat, perhaps indeed the parent of both, is gradually showing us its mysterious relations. Of two great practical consequences have these enquiries already been productive; namely, the electric telegraph, and the preservation of metals from corrosion. That others are upon the eve of their developement cannot be doubted; and in proportion as our knowledge of this agent, and consequent power over it, is extended, those ends must certainly be attained which we have above ventured to anticipate.

From other departments of this science we are constantly acquiring similar benefits: the progress of gas illumination, the great improve-

ments in metallurgic operations, in the arts of dyeing and calico-printing, in the manufacture of cements, in the preservation of timber from dry-rot, in gilding and silvering the metals, are only a few of the cases in point; even the difficult and apparently isolated researches into the relative proportions of the ultimate elements of the proximate organic products, and the application of the atomic theory to those researches, have not been fruitless, considered in reference to what are termed their practical results and popular and useful applications. The brewer and the distiller are reaping the benefits of such enquiries; the conversion of starch, and even of wood, into sugar, are the practical consequences of theoretical inferences. From the destructive distillation of ligneous matter we are already furnished with our chief supply of vinegar, and with a liquid which, as a combustible and a solvent, has to a great extent superseded the use of alcohol, and may perhaps replace it as an intoxicating stimulant: the sawdust of certain woods has been shown susceptible of conversion into nutriment; and the analysis of bone points it out, when properly prepared, as almost equal to its weight of flesh as an article of human food. All the forms of ammonia are now derived from what were once called the waste products of gas-works, and coal-tar has become the parent of a host of brilliant dyeing materials. In short, of the arts of life the greater number are dependent upon chemical principles; many of them, and perhaps the most important, are exclusively so; others, though apparently mechanical, involve chemical principles: hence the great and growing importance of chemical science as a branch of general education bearing upon political economy and upon the prosperity of the arts and manufactures.

Having given this outline of the rise, progress, and applications of chemical science from an early period to the beginning of the present century, we must refer to other articles for more explicit information upon the different heads that have been here briefly noticed. In reference to further details respecting the history of this department of knowledge, especially as relates to alchemy and to the history of chemical inventions, we may refer to Dr. Thomson's *History of Chemistry*, and to the prefatory chapter of the sixth edition of Brande's *Manual*.

The extent necessarily occupied by chemistry in a map of human knowledge will be evident from the brief definition of the science given at the outset of this article; for it not only leads us to enquire into the composition of every product of nature and of art, but to examine the elements of all the forms of matter, and the laws which govern their mutual actions and reactions. The questions which a chemist propounds to himself, in examining any newly discovered substance, involve therefore a long train of enquiries, which can only be answered and worked out by multiplied *experiments*; for it is impossible to move onwards in this science except upon the basis of experimental research. Accordingly, when a body of unknown nature is presented to a chemist, he endeavours, first, to ascertain whether it be a *simple* or a *compound* substance. If simple, to what class of elementary bodies does it belong? is it combustible or incombustible? is it electro-negative or electro-positive? how is it affected by heat? what are its relations to other forms of matter? what its powers of combination? what are the proportions in which it unites with other substances? what are its characters and those of its combinations as a chemical and physiological agent? what are its uses in the arts and in medicine? If it be a compound substance, he enquires into the nature and number of its component parts: are they new, or are they known elements? in what proportions are they combined? He also examines its thermal and electrical relations, and its useful applications. These, and many other questions which arise in the course of chemical investigation, involve as it were several distinct branches of enquiry, and lead us to contemplate chemistry under two points of view; namely, as an independent science, which embraces the whole field of chemical knowledge, and investigates the chemical relations of bodies without reference to any extraneous considerations—this is *pure*, *theoretical*, or *philosophical chemistry*; and secondly, as a science having certain objects in common with others, as with mineralogy, medicine, physiology, and the arts—this being *applied chemistry*.

In a subject, then, so extensive and complicated as chemistry, *systematic arrangement* is of the utmost importance to the teacher and student. In the broad principles of arrangement most writers agree; but in minor details each generally pursues a path of his own. It would be useless to enumerate the details of these arrangements as adopted by the leading didactic writers on chemistry; but the basis upon which they are founded deserves a few words of explanation.

The objects of chemistry are all included under one or other of the following heads; namely—

1. The general powers and properties of matter.
2. The chemistry of elementary substances.
3. The chemistry of compounds.

And each of these requires several subdivisions. Thus, under the first head, we include *attraction* and *affinity*, *heat*, *light*, and *electricity*; under the second head are included the chemical history and properties of the ponderable *elementary substances*, and their mutual *reactions*, which of course leads on to the third head; namely, to the chemical history and properties of *compound bodies*. To render the systematic arrangement of the elements and their compounds intelligible, it will be necessary to enumerate the former, and point out such of their characters as are connected with their classification.

Every substance upon our globe contains one or more of the following *sixty-five* elementary or simple bodies: some of them are of extremely rare occurrence, others abundant and always with and about us. It will be observed that by far the greater number of them come under the denomination of *metals*; of the others, oxygen, hydrogen, carbon, and nitrogen are of much the most frequent occurrence, as will be obvious when it is recollected that air and water and all vegetable and animal products include two or more of the last-mentioned substances.

The equivalent or combining proportions of these elements, although mentioned under individual substances in this work, are here subjoined [AFFINITY; ATOMIC THEORY; and EQUIVALENTS], and also the *symbols* by which they are represented:—

Table of the Simple Substances, with their Symbols and Equivalent or Atomic Weights. (The non-metallic Elements are printed in italics.)

Elements	Symbols	Atomic Weights
1 Aluminum	Al.	14
2 Antimony (Stibium)	Sb.	129
3 Arsenic	As.	75
4 Barium	Ba.	69
5 Bismuth	Bi.	213
6 *Boron*	B.	11
7 *Bromine*	Br.	78
8 Cadmium	Cd.	56
9 Cæsium	Cs.	123
10 Calcium	Ca.	20
11 *Carbon*	C.	6
12 Cerium	Ce.	46
13 *Chlorine*	Cl.	36
14 Chromium	Cr.	26
15 Cobalt	Co.	30
16 Columbium (Tantalum)	Ta.	184
17 Copper (Cuprum)	Cu.	32
18 Didymium	Di.	48
19 Erbium	Er.	?
20 *Fluorine*	F.	19
21 Glucinum	G.	7
22 Gold (Aurum)	Au.	197
23 *Hydrogen*	H.	1
24 Ilmenium	Il.	—
25 *Iodine*	I.	126
26 Iridium	Ir.	99
27 Iron (Ferrum)	Fe.	28
28 Lanthanum	La.	44
29 Lead (Plumbum)	Pb.	104
30 Lithium	Li.	7
31 Magnesium	Mg.	12
32 Manganese	Mn.	28
33 Mercury (Hydrargyrum)	Hg.	100
34 Molybdenum	Mo.	48
35 Nickel	Ni.	30
36 Niobium	Nb.	?
37 *Nitrogen*	N.	14
38 Norium	No.	?
39 Osmium	Os.	100
40 *Oxygen*	O.	8
41 Palladium	Pd.	54
42 Pelopium	Pe.	?
43 *Phosphorus*	P.	32
44 Platinum	Pt.	99
45 Potassium (Kalium)	K.	39
46 Rhodium	Ro.	52
47 Rubidium	Rb.	85
48 Ruthenium	Ru.	52
49 *Selenium*	Se.	40
50 *Silicon*	Si.	22
51 Silver (Argentum)	Ag.	108
52 Sodium (Natrium)	Na.	23
53 Strontium	Sr.	44
54 *Sulphur*	S.	16
55 Tellurium	Te.	64
56 Terbium	Tb.	?
57 Thorium	Th.	60
58 Tin (Stannum)	Sn.	59
59 Titanium	Ti.	24
60 Tungsten (Wolfram)	W.	92
61 Uranium	U.	60
62 Vanadium	V.	68
63 Yttrium	Y.	32
64 Zinc	Zn.	32
65 Zirconium	Zr.	34

The examination of the physical and chemical properties of the preceding elements of matter leads us to classify them according to their analogies. The greater number of them possess the characters of *metals*. Several resemble the metals in certain respects, but are in others widely different; these therefore have been termed *metalloids*. A few are distinguished by entering into peculiar and distinct saline combinations, of which common salt may be taken as the type; these therefore have been termed *halogens*. And lastly, three of the elements are only known in the gaseous form; they have neither been liquefied nor solidified, but whenever they are isolated they present themselves as permanent gases; hence they have been designated *gazolytes*. This is the classification of the elementary bodies suggested by Berzelius, and it represents them as follows:—

I. *Gasolytes*	II. *Halogens*	III. *Metalloids*	IV. *Metals*
Oxygen.	Chlorine.	Sulphur.	
Hydrogen.	Iodine.	Phosphorus.	
Nitrogen.	Bromine.	Carbon.	
	Fluorine.	Boron.	

The metals, by far the most numerous of the elementary bodies, are themselves the subjects of various classifications, among which the following is perhaps the most convenient:—

Potassium.	Cerium.	Niobium.
Sodium.	Lanthanum.	Ilmenium.
Lithium.	Didymium.	Molybdenum.
Cæsium.		Uranium.
Rubidium.	Iron.	Tellurium.
	Manganese.	Titanium.
Barium.	Zinc.	Antimony.
Strontium.	Tin.	Arsenic.
Calcium.	Cadmium.	
Magnesium.	Copper.	Mercury.
	Lead.	Silver.
Aluminum.	Bismuth.	Gold.
Glucinum.	Cobalt.	Platinum.
Zirconium.	Nickel.	Palladium.
Thorium.	Chromium.	Rhodium.
Yttrium.	Vanadium.	Ruthenium.
Erbium.	Tungsten.	Osmium.
Terbium.	Columbium.	Iridium.

Two which are but imperfectly known—namely, Norium and Pelopium—are excluded from this list. Altogether, the number of metals known is 52.

The first five of the metals upon the above list are distinguished as the metals of the alkalies; their oxides are powerfully alkaline; they have an intense affinity for oxygen, and

decompose water at all temperatures. The next four metals are the bases of the alkaline earths; with the exception of magnesium, they also decompose water at all temperatures. The ten succeeding metals, with the exception of aluminum, have been but imperfectly examined; they are generally designated as the bases of the earths. The following twenty-two metals have been sometimes divided into those which form basic oxides, and those which form acids; and they have been separated into other distinctive groups, having reference to the action of acids upon them, to their action upon water at high temperatures, and to the isomorphism of their salts; these characters, however, are not sufficiently definite; and as regards the basic or the acid character of their compounds with oxygen, several of them form compounds belonging to both classes. The last nine metals have been particularly designated as noble metals; they are not changed by air or by water, and their affinity for oxygen is comparatively feeble: to some of these properties, however, osmium forms an exception.

In one or other, then, of these classes, each elementary body will find a place; but the arrangement only relates to the simple substances. The classification of their *combinations*, which are almost indefinite, is a much more intricate and difficult subject, and it would be impossible here to give even an outline of the different plans which have been pursued or suggested. As far, however, as the teacher of chemistry is concerned, none of the systematic arrangements of compounds can be conveniently adopted: his best plan, therefore, is to develope their history and properties as he proceeds. Having, for instance, discussed the abstract properties of *oxygen* and *hydrogen*, he proceeds to the *compound* which they form, and which is *water*; then he proceeds to the third element *nitrogen*, and its *combinations* with those previously described; thus, nitrogen and oxygen form five distinct compounds, namely, *protoxide* and *binoxide* of nitrogen, and *hyponitrous*, *nitrous*, and *nitric* acids. Nitrogen also combines with hydrogen to form *ammonia*, and ammonia combines with nitric acid to form the salt called *nitrate of ammonia*. In a state of *mixture*, nitrogen and oxygen constitute the great bulk of the *atmosphere*.

From this brief notice of the mode of dealing with the three elementary bodies of the first class, the reader will readily understand the method of applying the same principle to the entire list; the student will thus be conducted, step by step, from the simplest to the most complicated chemical combinations. It is generally convenient, however, in adopting this plan, to exclude the products of organisation, and to consider them apart, under a separate head, entitled *organic chemistry*, which is of course subdivided into the *chemistry of vegetable* and of *animal products*.

If, having studied chemistry upon this plan, we look back upon the path which has been traversed, we shall immediately see that the *compounds* may be grouped into classes, related to each other by certain analogies both of properties and composition. Thus we have the class of *oxides*, or combinations of oxygen which are not acid; of *chlorides*, *iodides*, &c., and of *acids*; and these again subdivided into *oxyacids*, and *hydracids*; and lastly, the numerous class of *salts*, or compounds of the acids with salifiable bases.

When compound bodies are susceptible of electro-chemical decomposition (or *electrolytes*), the elements always tend to one or other pole; in other words, they are either separated at the point or surface at which the (presumed) electrical current enters, or at the surface at which it leaves the electrolyte; hence the arrangement of the elements into *electro-negative* bodies, or those which tend to the *anode*, and *electro-positive* bodies, or those which tend to the *cathode* (using the terms *anode* and *cathode* in reference to the ingress and egress of the electric influence); oxygen, the halogens, and sulphur are *anions*, or electro-negatives; hydrogen, and probably all the metals, are *cations*, or electro-positives. A good arrangement of the elementary bodies is founded upon such properties, although there are several whose electrical relations have not hitherto been accurately determined.

Chenocoprolite (Gr. χήν, *a goose*, κόπρος, *dung*, and λίθος, *stone*). An impure kind of Pitticite or Iron Sinter, containing a little silver and arsenate of cobalt. [GOOSE-DUNG SILVER.] It occurs in irregularly mammillated translucent masses of a yellowish-green or olive colour, in Cornwall, and at Allemont in Dauphiny; but chiefly at the mines of Clausthal in the Harz. It is a result of decomposition.

Chenopodiaceæ (Chenopodium, one of the genera). A natural order of monochlamydeous Exogens, distinguished with difficulty from *Amaranthaceæ* by their herbaceous calyx, and from *Phytolaccaceæ* by their solitary carpel, and the stamens never exceeding the number of the segments of the calyx, to which they are opposite. They consist of weeds inhabiting most parts of the world, abounding least within the tropics; and they possess few sensible properties. *Chenopodium anthelminticum* produces the Wormseed oil of the shops; but in consequence of their insipidity the species are often used for food, as in the case of spinach, &c. Chevalier has remarked the curious fact of *Chenopodium vulvaria* exhaling ammonia.

Cheque, Check or **Draft.** In Mercantile Law, is in legal effect an inland bill of exchange, drawn on a banker, payable on demand. It differs mainly from the latter in this, that the drawer of a check is not discharged by the holder's failure to present in due time, unless he have sustained from the delay actual prejudice, as by the failure of the banker. Much question having arisen as to the effect in law of the practice of crossing cheques, it was enacted in 1859 (21 & 22 Vict. c. 79, amending 19 & 20 Vict. c. 25), that a cheque crossed with the name of a banker should be paid only to that

banker; and if crossed with the words 'and Company,' or any abbreviation thereof, then only to some banker.

Chequy, Checky or **Chequered.** In Heraldry, a term used when a field or charge is divided by transverse lines, paleways and fessways, into equal parts or squares of different tinctures.

Cherimoyer. The Peruvian name of the delicious fruit produced by *Anona Cherimolia.*

Cherophylla. The poisonous principle of the *Chærophyllum sylvestre*, or Wild Chervil.

Cherry Coal. A soft Coal which resembles Caking Coal, but does not cake in burning. It requires little stirring, and gives out a cheerful flame and heat. The Staffordshire Coals principally belong to this variety, as do many of those of Glasgow, Derbyshire, Nottinghamshire, Lancashire, &c.

Chert. A silicious mineral with many of the characters of Flint, but differing from it in being of a tougher nature, and in breaking with a splintery instead of a conchoidal fracture. It is of common occurrence in the Carboniferous Limestone of Derbyshire, Flintshire, and of the south of Ireland, as well as in the Upper Greensand of Dorsetshire. On Holywell mountain in Flintshire it is quarried for the purpose of paving the bed on which flints are ground, for the composition of the body of pottery. The Chert which occurs largely in the Mountain Limestone near Charleroi and Namur, has been worked for millstones.

Cherubim. [SERAPHIM.]

Chess. This is unquestionably a very ancient game; but of its early history, and of the origin of the name, nothing is known with certainty. The suitors of Penelope are mentioned in the *Odyssey* as amusing themselves with a game called πεσσοί (answering to the Latin tesseræ, or *squares*), which is also named by Herodotus (i. 94). But this game probably more resembled our draughts than chess. The Spanish name Xague, if it be a variation of Xeque, points to the Arabic sheik, or chieftain, which thus reappears in the French échec. The term *checkmate* is identified by some with the Persian schah-mat, *the king is dead.* But Sir William Jones, by a derivation which takes us back to the Greek τέσσαρες and Latin tesseræ, ascribes the invention of the game to the Hindus, by whom it was called chaturanga, i.e. the four *angas*, or members of the army — elephants, horses, foot soldiers, and chariots. This word was, he thinks, changed by the Persians into chetrang, and further altered by the Arabs into shetrang, and thence by successive changes has become axidrez, scacchi, échecs, chess, 'and by a whimsical concurrence of circumstances has given birth to the English word *check*, and even a name to the *exchequer* of Great Britain.'

The game, which has undergone many modifications, is now played by two persons, with thirty-two pieces called *men*, on a square board divided into sixty-four equal squares, black (or red) and white alternately. Each player, therefore, has sixteen men, distinguished by their colour—those of one side being black (or red); of the other, white. The rows of squares which run from one player to the other are called files; those from side to side being known as ranks, or lines; while those which run obliquely are called diagonals, each diagonal necessarily consisting wholly either of black or white squares. The board is so placed that each player has a white corner at his right hand. The eight *pieces*, as distinguished from the eight pawns, consist of a king and queen, two castles or rooks, two bishops, and two knights, and are all placed on the rank nearest the player to whom they belong. Of these, the two rooks or castles occupy the two squares forming the angles of the board. The two knights occupy the squares next to the rooks, the two bishops being next to the knights, while the king and queen have each one of the two middle squares, the queen being on a square of her own colour. The pawns occupy the lines immediately in front of the pieces, and are named after the several pieces before which they are respectively placed, as king's pawn, queen's pawn, &c. The pawn moves straight forward on its own files; but captures its adversary obliquely or diagonally. The knight moves by leaping obliquely over an adjoining square to one of the next squares, of a different colour from that which it leaves. The bishop moves diagonally forward or backward, over any number of squares at one time, if the course be open. The castle or rook moves straight forward, or backward, or sideways any number of squares at a time, provided these are unoccupied by other men. The queen can move either like a castle or a bishop, while the king moves only one square at a time, in any direction. When an attack is made upon a king by any piece or pawn, he is said to be in *check.*

The object of the game is to give *checkmate*, which takes place when the king is so beset that he can neither move out of check, nor take the piece or pawn that checks him, nor interpose any piece for his protection. *Stalemate* occurs when the king is not in check, but yet cannot move without going into check, all his men being at the same time off the board, or so placed that none of them can move; in such cases the game is held to be drawn. It is also a drawn game when neither party can give checkmate to the other.

The first practical book on chess is the *Repeticion de Amores* of Ramirez de Lucena, printed probably at Salamanca about 1495. Caxton, in his *Game and Play of the Chess*, merely moralises on the game. The subject is elaborately treated in Staunton's *Handbook of Chess.*

Chessylite or **Chessy Copper.** Blue carbonate of copper. It is composed of 25·43 per cent. of carbonic acid, 69·37 oxide of copper, and 5·20 water; and, when pure, contains 55·16 per cent. of copper. Earthy varieties are of a smalt-blue colour, but when crystallised it is of

a beautiful azure-blue with a vitreous lustre, and varying from transparent to opaque. It occurs less frequently than Malachite, in the same localities, and, like it, is the result of the decomposition of other ores of copper (Grey Copper, Red Copper, &c.), with which it is associated. When in sufficient quantity, it constitutes a valuable ore of copper. The name Chessylite is derived from that of the locality, Chessy, near Lyons, where the mineral is met with abundantly, in very beautiful crystals, and also in a fibrous state.

Chevalier (Fr. from cheval, *a horse*). Is used synonymously with the Eng. knight, Lat. eques, and Ger. ritter.

Chevaux de Frise (Fr.). Large and strong pieces of timber, traversed with wooden spikes pointed with iron. Sometimes they are made entirely of iron. They are used as an obstacle to impede the advance of troops.

Chevrette. In Artillery, an engine used for raising guns or mortars into their carriages.

Chevron (Fr.). In Heraldry, one of the nine honourable ordinaries. It may be defined as consisting of the lower half of a saltire [SALTIRE], brought to a point on the upper side. The object from which its name is derived accurately resembles it in shape; chevron, in old French, meaning the support of a roof formed by two rafters leaning against one another. A chevron standing on one side of the escutcheon is said to be tourny, dexter, or sinister. A Chevronel is an ordinary of the same shape with the chevron, but containing only half its dimensions.

CHEVRONS. The stripes worn on the arm by a non-commissioned officer in the army to distinguish his rank. A staff-sergeant wears four, a sergeant three, a corporal two, and a lance-corporal or bombardier one chevron.

Chian Turpentine. A species of turpentine brought originally from the island of Chios: it is the produce of the *Pistacia Terebinthus*.

Chiaro-scuro (Ital. *clear-obscure*, literally light-dark). In Painting, the art of disposing the lights, both positive and reflected, and the shadows of a picture, in such a manner that the objects may stand out and be naturally relieved from one another. It means the mutual relation between light and dark masses. Its name, however, seems more naturally to point to those parts of represented objects which, though in shadow, have the intensity of such shadow lessened by the reflection of a light body against them. It is a branch of Sciography, and Rembrandt is one of the most illustrious masters in the art.

Chiastolite. Macle or Hollow Spar. A variety of Andalusite found embedded most frequently in clay-slate, but sometimes in mica-schist. It occurs in the slate of Cumberland and of Wicklow, in the Pyrenees, &c. It is always crystallised, and the crystals are in the form of rhombic prisms which are externally greyish-white, and present internally a black or bluish-black cross in their transverse section. This appearance is produced by prisms of a darker substance in the centre, and sometimes at each angle, connected by thin plates of the same, consisting sometimes of a carbonaceous substance and sometimes of clay-slate. The name Chiastolite was given to this mineral from the circumstance of the dark lines on the sections of the crystals resembling the Greek letter *chi*: hence the term, from χιαστός, marked with a χ.

Chica. A red colouring matter used by some tribes of American Indians of the Orinoco and Rio Negro to stain the skin; it is extracted from *Bignonia Chica*.

Chicken-pox (*Varicella* of medical writers). An eruptive disease, which, though frequently very mild in its attack, is often also violent and attended by much fever. The eruption consists of smooth vesicles of various sizes, which afterwards become whitish and straw-coloured; about the fourth day they break and scab off, seldom leaving marks, or at least not more than a few, upon the most delicate parts of the face, or where they happen to have been large or accidentally scratched or irritated. In very warm weather the fluid in the vesicles becomes yellow, and apparently purulent, so as closely to resemble small-pox in appearance; and under some circumstances, the eruptive fever has been not only considerable, but preceded by delirium. The distinctive or diagnostic characters by which we distinguish chicken-pox from small-pox are: 1st. The comparative mildness of the preliminary fever, which indeed is often unobserved in strong and merry children, nothing being known of the complaint till spots are observed about the face and breast. 2nd. The rapidity with which the eruption attains maturity and proceeds through its stages, the scabs forming crusts about the fourth or fifth day, which does not happen in the small-pox till the tenth or eleventh. 3rd. The fluid in the vesicles is usually transparent, or only milky, whereas in small-pox it has a purulent appearance from the commencement. Like the small-pox, it very rarely attacks the same individual more than once. In the treatment of this disease little else is in most cases requisite than to keep the patient cool, to abstain from meat, to give diluents and mild aperients, and occasionally, at the commencement, a dose of calomel and rhubarb. In bad cases, the whole body is covered with eruption, but in mild ones there will only be a very few vesicles; and it not uncommonly happens that where several children have it in succession, one or two will escape with little else than slight restlessness and very trivial febrile symptoms. It is, however, by no means so trifling a disease as many writers have represented it, and if not closely watched over may be mistaken for small-pox.

Chief (Fr. chef, *head*). In Heraldry, the upper part of the escutcheon, divided into three points, dexter, middle, and sinister. A chief, as an ordinary, is a fess removed to the upper part of the escutcheon. Charges, in the situation of the chief, are described as 'in chief.'

Chilblain. An inflammatory swelling, of a purplish colour, produced by exposure of the extremities to cold: it is generally attended with itching and often shooting pains. Children, especially those of a scrofulous habit, and old persons, suffer most from chilblains; but they are not unfrequently produced at all times by holding the hands or feet to the fire after they have been exposed to great cold; in which case, the difference of temperature is such as actually to burn the part, for few persons are aware of the high temperature excited by the radiant heat of a common fire upon substances held near it. Warm socks and gloves are the best preventives against this affection, and the itching and pain are generally relieved by moderately stimulating applications, such as equal parts of solution of acetate of ammonia or of vinegar and spirits of wine, or of oil of turpentine and soap liniment. If the part should break or ulcerate, stimulating dressings, such as the resin or elemi ointment, are most serviceable, or in some cases mild escharotics.

Child-bishop. [BOY-BISHOP.]

Childrenite. A hydrated phosphate of alumina and iron with more or less protoxide of manganese, magnesia, &c. It has been found in Cornwall, in yellow or brownish-yellow crystals or crystalline coatings on Sparry Iron, Pyrites or Quartz, at Crinnis Mine near St. Austell, at the George and Charlotte Mine, and at Huel Crebor.

Named after the late Mr. Children, of the British Museum.

Chileite. The name given by Keugott to a vanadate of lead and copper found at Mina Grande in Chili, where it occurs in cavities in arseno-phosphate of lead with amorphous carbonates of lead and copper. It has a dark-brown or brownish-black colour, and an earthy appearance like that of a ferruginous clay or earth.

Chiliad (Gr. χιλιάς, *a thousand*). An assemblage of things grouped or ranged by thousands. The word is chiefly used by the early computers of logarithmic tables, who expressed the extent of the table by saying it contained the logarithms of so many *chiliads* of absolute numbers.

Chiliasts (Gr. χιλιασταί). In Ecclesiastical History, believers in the second advent of Christ to reign a thousand years on earth. [MILLENNIUM.]

Chilognathes, Chilognatha (Gr. χεῖλος, *a lip*, and γνάθος, *a jaw*). An order of the class *Myriapoda* or *Centipedes*, in which the two mandibles and the tongue are united together to form a large lower lip.

Chiloma. In Zoology, the upper lip or muzzle of a quadruped is so called when it is tumid, and continued uninterruptedly from the nostril, as in the camel.

Chilopods, Chilopoda (Gr. χεῖλος, and πούς, *a foot*). An order of the class *Myriapoda* or *Centipedes*, in which the lower lip is formed by a pair of feet.

Chiltern Hundreds. In Politics. The tract anciently called the Chiltern Hundreds extends through part of Buckingham and Oxford shires. The steward of these hundreds was an officer appointed by the crown to keep the peace there. As members of parliament, strictly speaking, cannot resign their seats, the mode of abandoning them is by accepting a nominal office (such as this stewardship) under the crown, which vacates the seat of the party taking it.

Chimæra (Lat.; Gr. χίμαιρα). In Ichthyology, the name of a genus of Branchiostegous cartilaginous fishes; the best known species, which inhabits the northern seas, and has occasionally been taken on our own coast, is sometimes called 'king of the herrings.'

CHIMÆRA. In Mythology, is described in the *Iliad* (vi. 181) as having the head of a lion, the body of a goat, and the tail of a dragon. Many different forms are, however, assigned to it by other poets; and the word, in nearly all the modern languages of Europe, has come to mean any wild or incongruous fancy arising in the mind.

Chimaphila (Gr. χεῖμα, *winter*, and φιλέω, *to love*). A genus of *Pyrolaceæ*, called Wintergreen in North America, where it is valued for its tonic and stomachic properties. The leaves are bitter-sweet.

Chimney (Fr. cheminée, Lat. caminus). The place in a room where the fire is burnt, and from which the smoke is carried away by means of a flue. That part of the opening which faces the room is properly the *fireplace*, the stone or marble under which is called the *hearth*, that on a level with the hearth is called the *slab*; the vertical sides of the opening are called the *jambs*; the head of the fireplace is called the *mantle*; and the cavity, or hollow, from the fireplace to the outlet, is called the *funnel*. The part of the funnel which contracts as it ascends is termed the *gathering*, or by some it is called the *gathering of the wings*. The tube or cavity, usually of a parallelogrammatic form in plan, from the point where the gathering ceases up to the top of the chimney, is specifically called the *flue*, and the part between the gathering and the flue is called the *throat*. The part of the wall facing the room, and forming one side of the funnel parallel thereto, or the part of the wall forming the sides of the funnel, where there is more than one, is the *breast*. In external walls the side of the funnels opposite the breast is called the *back*. When there is more than one chimney in the same wall, the solid parts that divide them are called *withes*; and when several of such chimneys are collected into one mass, it is called a *stack of chimneys*. The part which rises above the roof for discharging the smoke into the air, is called a *chimney shaft*, whose horizontal upper surface is called the *chimney top*. The covings or the linings of the jambs used formerly to be placed at right angles to the face of the wall: but Count Rumford showed that by inclining them the heat was increased by the quantity reflected

from their surface. He also taught builders to place the fire as near the hearth as possible, and he showed the advantage of contracting the funnel as much as possible. Generally speaking, flues are made 9 inches wide by 14 inches long; but these dimensions were adopted for the convenience of the climbing boys, who could not ascend in less dimensions; there seems to be no reason, now that the machine is used, for retaining them, and it certainly would be better to make them 9 inches square, for the generality of fireplaces at least. [FIREPLACE; GRATE; STOVE.]

Chimney Stalk. This word is usually applied to a lofty chimney, such as are erected for steam-engines. It is recommended that the dimensions of them should be as follows (*Civil Engineer Journal*, xviii. 319):—

	Diam. at top, inside.		Nominal horse-power.
Yds. high.	ft.	in.	h.-p. of boiler.
20	1	6	10
25	1	8	12
30	1	10	16
33	2	0	20
35	2	6	30
40	3	0 to 4 ft.	50 to 90
45	4	6	120
50	5	0	160
55	5	6	200
60	6	0	250

Chimpanzee, Chimpanse or **Quimpese.** Native names of the African orang (*Troglodytes niger*, Geoff.). It is of a black colour, and attains the height of between four and five feet, measured in a straight line from the vertex to the heel. For many years the osteological evidences of the structure of this animal, as well as the proofs of the habits and manners of the adult, were unknown to British readers, who were only acquainted with it from observation of the young specimens. It differs from the Asiatic or Red Orang not only in colour, but in the greater size of the external ears, the more prominent supraorbital ridge, the relative shortness of the arms, and the greater developement of the thumb of the hind foot, which has constantly two phalanges and a nail. The principal osteological differences between the genera *Troglodytes* and *Pithecus* are the following: The cranium is flatter and broader in proportion to the face. The supraciliary ridges are more developed; and the great interparietal and lambdoid crests, which render so remarkable the skull of the adult orang, are in the chimpanzee wanting. The interorbital space is broader. The occipital foramen has a more central position. The anterior condyloid foramen is single on each side, while in the orang it is double. The intermaxillary sutures are obliterated before the deciduous incisors are shed. The incisive and canine teeth are of smaller proportional size. There are thirteen pairs of ribs instead of twelve pairs, as in the orang; and consequently there are thirteen dorsal vertebræ. The sternal bones form a single row. The chimpanzee further differs from the orang-utan in the non-division of the pisiform bone of the wrist; and in the depression at the head of the femur, corresponding to the interarticular ligament of the hip-joint, which is wanting in the orang.

The habits and deportment of the chimpanzee, as observed in those young specimens which have been brought alive to this country, are of peculiar interest, from the high degree in which inquisitiveness, perception, memory, and docility are manifested; and by the gravity and consideration with which many even of its ludicrous and playful actions are performed. It is probable, however, that in the adult much of this intelligence gives way to the fiercer traits of the brute nature.

We have also had evidence of a larger species of Troglodytes, the GORILLA [which see].

China Clay or **Kaolin** (*Pe-tun-tse* is the name of a variety). A clay used in manufacturing porcelain. *China stone* is also a material used in the manufacture of porcelain, and nearly of the same nature. Large quantities of china clay and china stone are obtained from Cornwall and Devonshire for the use of the English potteries. The *china stone* is a partially decomposed granite covering the surface of much of the middle of Cornwall. It consists of the felspar crystals partly broken up and mixed with a quantity of silica. This material is calcined and ground before exportation. *China clay* is the more completely disintegrated felspar reduced to a state of fine division, and separated by washing from the coarser particles and sand with which china stone is mixed up. When mechanically separated from impurities, it is bleached by sun and air and dried into bricks about a foot cube, which are exported to the potteries. From some of the deposits the natural clay is sufficiently pure to be exported at once. About 14,000 tons of prepared and 30,000 tons of natural china clay were sent some years ago from one district. The composition of *kaolins* varies greatly. [KAOLIN.]

The china clays of France and Germany, used in the celebrated manufactories at Sèvres and Dresden, are obtained from the granite districts of those countries, as doubtless is the case with China and Japan, where hard china of the finest kind has been made from time immemorial.

China Ink. A finely divided carbon, probably lampblack of some kind, mixed with gelatine, and formed into cakes or sticks. It is sometimes stated to be the desiccated ink of the cuttle-fish.

China Root. The root of the *Smilax China*, so called because imported from China. It was formerly used in the same cases in which sarsaparilla is now given.

Chinchilla. The generic appellation founded on the South American or local name 'chinchille,' or 'little chinche,' and applied to a genus of gnawing Mammalia or Rodents peculiar to the South American continent. It

is from a species of this genus (*Chinchilla lanigera*) that the grey fur is obtained which has been so much prized in Europe for many years; but the exact nature of the animal itself has been only very recently ascertained, by the examination of specimens which have been procured for the menagerie of the Zoological Society.

Chinese Architecture. [ARCHITECTURE, CHINESE.]

Chinese Swallows' Nests. These curious productions were formerly supposed to have been made of some kinds of seaweed, as *Sphærococcus lichenoides*; but they are ascertained to be formed of a secretion from the mouth of the bird itself.

Chinoidine. *Quinoïdine, Cinchoidine.* Uncrystallisable cinchona alkaloids, resulting from the action of heat in drying cinchona bark and in extracting the active principles. It also contains colouring matter and resin.

Chinoleine. *Quinoline, Cincholine, Leucol, Leucoline.* An oily volatile alkaloid, derived from the cinchona alkaloids by distillation with caustic potash.

Chinone. A substance obtained by distilling certain salts containing kinic (cinchonic) acid, as for instance the kinate of lime, with oxide of manganese and sulphuric acid. Chinone sublimes in the form of golden-coloured crystals, soluble in water, very volatile, and of a very peculiar and distinctive odour. Their formula is said to be $C_{25}\,H_8\,O_8$.

Chinovic Acid. *Quinovic* or *Quinovatic* or *Kinovic Acid.* An acid occurring in small quantity in cinchona bark.

Chintz. A peculiar pattern upon printed calicoes, in which flowers and other devices are printed in five or six different colours, upon white and coloured grounds. A good chintz pattern in fast colours is one of the most surprising and difficult efforts of the art.

Chiococcic Acid. *Chiococca* is the botanical name of cainca root. It appears to be identical with *chinovic acid.* [CAINCIC ACID.]

Chiolite. A fluoride of sodium and aluminium forming a vein in graphic granite at Miask in the Ural. It sometimes is found in octahedral crystals, but generally compact like Cryolite, with a crystalline structure, snow-white, and with a vitreous lustre.

Chip. A material obtained from the leaves of the palm called *Thrinax argentea*, and used for plaiting into hats and other articles of utility or ornament.

Chiragra (Gr. χειράγρα). Gout in the hands.

Chirata or **Chiretta.** The Indian tonic *Agathotes Chirata.*

Chirograph (Gr. χειρόγραφος, *written with the hand*). In Diplomatics, a species of instrument contrived for the purpose for which indentures were devised; viz. the enabling different parties to retain authenticated counterparts of the deed. Some word (commonly the word *chirographum*, whence the name) was written between the two copies on the same sheet, and cut through lengthwise when they were divided.

Chirology (Gr. χείρ, *the hand*, and λόγος, *discourse*). The language of the fingers; sometimes called *dactylology*, from δάκτυλος, *the finger.*

Chiromancy or **Palmistry** (Gr. χειρομαντεία). The imaginary art of divination by the lines of the hand. According to the science of Chiromancy, the lines on the palm of the hand are divided into principal and inferior; the former are five—the line of life; the line of the liver or natural mean; the line of the brain; the thoral line, or line of fortune; the dragon's tail, or discriminal line, between the hand and the arm. Various other modes of divination were practised by observation of the hand and its parts; onychomancy (from onyx, a nail), dactylomancy (from the fingers), &c. The practice of chiromancy, once defended and explained by grave and learned authors, is now chiefly left to be exercised by the gipsies.

Chironomy (Gr. χειρονομία). The science which treats of the rules of gesticulation, or pantomime and oratorical action.

Chisel (Ital. cisello; Fr. ciseau). The name given to some kinds of tools having a cutting edge at the base of a metal blade, and bearing an upper portion adapted to receive an impulse either from the hand or a hammer. The use of these instruments is of great antiquity, as the Egyptians used those made of bronze; and the occurrence of flint implements of this kind proves that they were well known in the very earliest periods of civilisation.

Chitine. The hard insoluble matter forming the shells and elytra of insects.

Chiton (Gr. χιτών). The name of a genus of Gastropodous Molluscs, which have a series of testaceous symmetrical pieces implanted in the back part of the mantle.

Chivalry (Fr. chevalerie). The usages and customs pertaining to the order of knighthood. The general system of manners and tone of sentiments which the institution of knighthood, strictly pursued, was calculated to produce, and did in part produce, during the middle ages in Europe, is comprehended in ordinary language under the term of *chivalry.* This imaginary institution of chivalry, such as it is represented in the old romances, had assuredly no full existence at any period in the usages of actual life.

The origin of chivalry has often been traced to the German tribes; nor has its spirit ever penetrated very deeply into the usages of any country in which these tribes have not either produced the ancestors of the great body of the nation, or at least the conquering and governing class, which transfused its habits and sentiments into that body. Thus Germany and France, and England, whose gentry derive their origin from both, have been the countries most distinguished for the prevalence of this institution. The martial spirit of the Spaniards was indeed partly animated by it; but in their country it always bore something of the cha-

racter of a foreign importation, modified by the circumstances of their juxtaposition with the Arab race. In Italy, it existed only among those classes which imitated the manners of France and Germany, and never entered into the general character of the natives, notwithstanding the popularity of the poetical romances of chivalry. Among the Slavonic nations it has never prevailed extensively; although the feudal constitution of Polish society derived a certain tincture from it, it never penetrated into Russia. It has been often remarked, that it is only within the last two or three generations that the nobility of that country, by their intercourse with the nations of Western Europe, have derived something of the spirit of the chivalrous code, so far as it still subsists among ourselves. The point of honour, and its peculiar concomitant the usage of the duel, were scarcely known in Russia before the present century.

Chivalry originated in the feudal attachment of warriors to the person of their king or chief, which has been so often described as characteristic of the ancient Germans. Hence the English word *knight*, which, when the Norman 'chevaliers' were first known among us, was spontaneously used as the translation of their title, signified originally a servant or attendant. At what precise time the devotional character was added to the original martial impress of national usages, and the compound system of chivalry was thus produced, it is not easy to ascertain. It has been said that the investiture of the knight was purely military until the reign of Charlemagne; and it may be supposed that the wars of the Franks against the Saracens first blended the ardour of war and religion together, and that the Crusades completed the union. At the latter period were instituted the two celebrated military orders of monks, the TEMPLARS and HOSPITALLERS [which see], the code of whose government combined monastic and knightly usages. After valour and devotion, the third characteristic feature of chivalry was gallantry to the fair sex; and the source of this sentiment also has been traced to the habits and feelings of the Northern tribes, among whom woman was looked on with a much more exalted sense of her dignity than in the most civilised countries of antiquity. It is needless to add, that this romantic feeling, however high its precepts may have sounded in theory, degenerated into licentiousness in actual life. M. de Sainte-Palaye, the learned French historian of the usages of chivalry, has brought instances enough to prove the extreme depravation of manners which prevailed, even in those courts and at those periods in which the spirit of chivalry was most prevalent. If the Crusades communicated to chivalry its devotional character, it is in the poetry of the Troubadours about the same period, in the twelfth and thirteenth centuries, that we find its peculiarity of devotion to the female sex first developed. But in their verses it does not appear clothed with the romantic purity with which it was afterwards invested by the writers of the heroic tales of chivalry, and still less in those of the contemporary French writers of the *Fabliaux*, from whose compositions we draw the most authentic monuments which we possess in this curious branch of antiquarian research. The knight, or even the esquire, was bound to follow a single lady and dedicate himself to her service; but little delicacy is either intimated or enjoined in the relations which subsisted between them, and his devotion to her was considered as entitling him to every recompense love could bestow.

The fourteenth century was the brilliant period of chivalry, when its usages, originally formed in the manners of the people, had become fixed and embellished by the fictions of the writers of romances; and when princes and chieftains, forming their idea of the institution rather from the descriptions contained in them than from real life, sought to bring back their courts and camps to the likeness of those ideal models of perfection. It may be more truly said that the romances of chivalry were the prototypes of that state of courtly society which existed in the reigns of our Edward III. and Richard II., and of which Froissart has left us such accurate and lively representations, than that existing manners and sentiments furnished the subject-matter of those romances. These fictions, of which the heroes were taken from among a long list of fanciful personages, in whose history a little tradition of past events was blended with a much larger proportion of fable, represented the knight not only as devoted to the service of his religion, his lord, and his mistress, but also as consecrated to the general service of the oppressed, and to the maintenance of right all over the world. There can be little doubt that the peculiar ceremonies which in the fourteenth and fifteenth centuries accompanied the creation of a knight—the vow of chivalry, the watching, prayer, and fasting, &c. —were borrowed by romantic imaginations from such fabulous recitals, which were read and related in every courtly company. Before that period, the manners of the knights and dames had exhibited but little of that polish and refinement, their sentiments but little of that generosity, which were the subjects of so much imaginary description; and, in later times, chivalry gradually decayed. Its usages were maintained with even more of magnificence than before; its various rites, titles, and distinctions subsisted for a long period in most European countries, and partly remain to this day; but the spirit of feudal devotedness was quenched by the multiplication of mercenary troops; adherence to a feudal lord was superseded by the more general feelings of national patriotism (which was almost wholly omitted in the chivalric code), and the extravagances into which the imaginary point of honour had led its votaries, fell into discredit and ridicule.

It is, therefore, to the fourteenth century, and especially to that part of its chronicles preserved by the true annalist of chivalry, Froissart,

that we must look for the period when the line between real society and that represented in romances was most nearly broken down. When the usages of chivalry were most flourishing, all men of noble birth (except the highest) were supposed to pass through three orders or gradations. They first lived as pages in the train of nobles and chiefs of high rank; next, as esquires, they attached themselves to the person of some individual knight, to whom they were bound by a strict law of obedience, and for whom they were bound to incur every danger, and, if necessary, sacrifice their lives; and, thirdly, they were promoted to the rank of knighthood. (For the different orders of knighthood, see KNIGHT.) It is sufficient to observe here, that however great the distinction might be between knights in point of rank and wealth, custom established a species of equality among all of the same order, which may be said to subsist among gentlemen of the present day. They formed, all over Europe, a common corporation, as it were, possessing certain rights, and owing each other certain mutual duties and forbearances. They were united, not by the ties of country, but by those of feudal obedience, which attached every knight to the banner of his liege lord, from whom he held his fee; but little or rather no dishonour attached to knights who were under no such feudal tie, if they chose their own chieftain wherever they thought fit: they were free adventurers, whose order was a passport in every service; and, in the actual conflict, the hostility of knights was moderated by usage. Thus, it was dishonourable in any knight to take a knight's life if disarmed, and not to set him free when a prisoner on receiving a fitting ransom. Manny and Chandos, the two most celebrated knights of Edward III., were attached wholly to the banner of their sovereign, and not to that of their country; and although the French constable Duguesclin, the third among these mirrors of chivalry, appears to have been devoted to the cause of France as well as to that of his master, this double loyalty found few imitators. In peace, also, knights of all countries were welcome visitors at the courts of chivalric sovereigns; and all enjoyed the privilege of presenting themselves at the tournament, and contending there for the prize.

With regard to the point of honour, which forms the most important feature in the usages of chivalry, see some details under the article DUEL. The principal objects to which it related were: religious belief; fealty to the feudal superior; devotion to some one selected lady; and, finally, the general character for honour and courtesy which it was incumbent on a knight to maintain; for although his imaginary duties, as a knight-errant, to avenge wrong and succour the oppressed on every occasion, were not of course very strictly put in practice, yet his vow to perform those duties attached to his character a certain degree of sacredness which it was necessary to maintain. Chivalrous honour was chiefly supported in two ways: first, by the single combat or duel, whether on account of serious provocation or by way of trial of strength; secondly, by the performance of vows, often of the most frivolous and extravagant nature. These were generally undertaken for the honour of the ladies. Many historical instances of these absurd yet daring follies are recorded by Froissart; and with other usages of knighthood, they were long preserved among those who aimed at the reputation of chivalry, after these usages had ceased to form a part of the ordinary customs of society. Thus, the instances which Froissart relates of knights riding alone up to the barriers of fenced cities, &c., were imitated in after-times, and at no less personal hazard, by such romantic personages as Lord Herbert of Cherbury, whose feats, performed in rivalry with the French champion Balagny, are mentioned in his Memoirs. But the vows related not only to martial achievements, but to others of a more extravagant and grotesque character. We need only refer to Monstrelet's narrative of the company called 'Galois' of knights and ladies, who bound themselves, for love of each other, to follow a particular code of usages; of which a part consisted in wearing thick clothes in summer and thin in winter, to show that the power of their love rendered them insensible to the difference of seasons; a vow which was maintained with such perseverance, that the greater part of the devoted company actually died of cold. (See also the *History of the Vow of the Heron*, Sainte-Palaye, vol. iii.) The commencement of such extravagances, however, betokened the decline of the true spirit of chivalry. It decayed with the progress of mercenary armies and the decline of feudal institutions through the fifteenth century: in the sixteenth, it was little more than a lively recollection of past ages, which knights such as Bayard and sovereigns such as Francis I. and Henry VIII. strove to revive; and, finally, it became extinguished amid religious discords, leaving as its only relic the code of honour, which is still considered as governing the conduct of the gentleman.

Chiviatite. A lead-grey coloured mineral resembling Bismuth Glance, found in foliated masses with Pyrites and Heavy Spar at Chiviate in Peru. It is a sulphide of bismuth, lead, copper, iron, &c.

Chladnite. A mineral found in a meteoric stone which fell at Bishopville in North America, and named after Chladni; it is a tersilicate of magnesia.

Chlamyphore, Chlamyphorus (Gr. χλαμύς, *a cloak*, and φέρω, *I carry*). A name given to a small species of Armadillo, which is covered by its coat of mail as by a cloak. The animal is not above six inches long, and, like the rest of its genus, inhabits exclusively the continent of South America. In its habits it is said to resemble the mole. It is interesting from the analogy of its skeleton and coat of mail to those of the gigantic extinct megatherium.

Chlenaceæ (Gr. χλαῖνα, *a cloak*: all the names of genera belonging to this order are compounded of this word, used in a figurative sense for an involucrum). A natural order of shrubby or arborescent Exogens, allied to *Malvaceæ*, on account of their monadelphous stamens and involucrated flowers, but referred by Jussieu to the vicinity of *Ebenaceæ*. Their imbricated calyx, regular flowers, and abundant albumen has induced Lindley to place them in his Geranial alliance. Hooker and Bentham, however, place them at the end of their Guttiferal alliance, near to *Malvaceæ*. They are all natives of Madagascar, beautiful in their flowers, but of no known use.

Chlor-iodoform. A heavy yellow aromatic liquid derived from chloroform by the introduction of one equivalent of iodine in the place of chlorine.

Chloracetic Acid. A crystalline acid obtained by the action of the solar rays upon a mixture of chlorine with the vapour of acetic acid. Its formula is $C_4\,Cl_3\,O_3$, H O; in it, therefore, the hydrogen of the acetic acid is replaced by chlorine.

Chloral (a word made up of the first syllables of *chlorine* and *alcohol*). A liquid composed of chlorine, carbon, hydrogen, and oxygen, obtained by the action of chlorine upon absolute alcohol. Its formula is $C_4\,H\,O_2\,Cl_3$.

Chloramilal. A liquid derived from amylic alcohol by the action of chlorine.

Chloranthaceæ (Chloranthus, one of the genera). A small natural order of apetalous Exogens, nearly allied to *Saururaceæ* and *Piperaceæ*, from both of which it differs in wanting a sac to the embryo, and in having a pendulous ovule and opposite leaves with intermediate stipules. They are natives of the hotter parts of the world, and appear to possess stimulating properties of great importance. *Chloranthus officinalis* and *brachystachys*, although not officinal in Europe, are powerful stimulating agents.

Chlorapatite (Gr. χλωρός, *green*, and Apatite). A variety of Apatite from Krageröe in Norway, distinguished by the absence of fluorine, and the presence of a small variable quantity of chloride of calcium.

Chlorastrolite (Gr. χλωρός; ἄστρον, *a star*; and λίθος, *stone*). A pale bluish-green mineral found on the shores of Isle Royale, Lake Superior, in small rounded waterworn pebbles, which have been derived from trap rock. It is finely radiated or stellate in structure, with a pearly lustre, and is chatoyant at the rounded sides. It is a hydrated silicate of alumina, iron, lime, and soda.

Chlorates. Combinations of chloric acid with salifiable bases. Of these salts the *chlorate of potash* is best known; it was formerly called *oxymuriate of potash*. When mixed with combustibles, such as sulphur or charcoal, and some of the metals, it forms highly explosive compounds, which ignite by a blow or by friction, or upon the contact of sulphuric acid. A mixture of this salt with sugar, or with sulphuret of antimony, was used in tipping the *matches* which inflame when dipped into sulphuric acid, but which are now superseded by mixtures containing phosphorus, which are inflamed by simple friction. Chlorate of potash consists of 76 chloric acid + 48 potassa = 124 of the chlorate.

Chlorazol. An acid poisonous pungent liquid resulting from the action of nitrohydrochloric acid on albumen.

Chlorhydric Acid. [Hydrochloric.]

Chlorhydrines. Oily liquids derived from glycerine by the action of varying quantities of hydrochloric acid.

Chloric Acid. A compound of 1 atom of chlorine with 5 of oxygen, represented therefore by the formula $Cl\,O_5$. Its most important salt is the chlorate of potash.

Chlorides. Combinations of chlorine, corresponding to the oxides. Common salt is a *chloride of sodium*; that is, a binary compound of chlorine and sodium. Where there are two chlorides of the same base, the relative proportions of chlorine in them are almost invariably as 1 to 2; hence the terms *protochloride* and *bichloride*.

Chlorimetry. The estimation of the available chlorine in any bleaching compound of that element. There are several chlorimetric processes, but that of Dalton is the most convenient. To a known quantity of protosulphate of iron acidified with hydrochloric acid, the bleaching compound is added until the iron is all peroxidised. As the quantity of chlorine necessary to do this can be calculated, the value of the sample is easily ascertained from the weight of it used in the process. The richer the specimen, the less of it will be required.

Chlorine (Gr. χλωρός, *pale-green*). Chlorine was discovered in 1774 by Scheele, who called it *dephlogisticated muriatic acid*; the French nomenclaturists afterwards termed it *oxygenated muriatic acid*, conceiving it to be a compound of oxygen and muriatic acid. This erroneous view of its nature was corrected in 1809 by Sir H. Davy, who gave it the present name, indicative of its colour. Chlorine is a simple substance, existing at common temperatures and pressures in the gaseous state; but when subjected to a pressure of about four atmospheres it becomes condensed into a yellow transparent liquid, which is a non-conductor of electricity. 100 cubical inches of chlorine, at mean temperature and pressure, weigh between 76 and 77 grains: water absorbs twice its volume, and acquires a yellow colour, and the peculiar suffocating odour of the gas. When humid chlorine is exposed to a temperature of 32°, it assumes a crystalline form; this *hydrate of chlorine* consists of 1 equivalent of chlorine = 36 + 10 of water = 9 × 10, or 90. Chlorine is not only unrespirable, but very injurious when breathed, even if largely diluted: a taper burns in it with a red smoky flame, and is soon extinguished. Some of the metals, when finely divided, spontaneously take fire in chlorine, such as brass leaf, or powdered

antimony. A remarkable property of chlorine is its power of destroying almost all vegetable and animal colours; hence the important application of this gas and of some of its combinations to the *art of bleaching*. It also destroys the putrid odour of decomposing vegetable and animal substances, and infectious effluvia of all kinds, whence its use in fumigation, and in preventing the spread of infectious and contagious matter, and purifying noxious atmospheres.

The great natural source of chlorine is *common salt*, which contains it in the proportion of about 60 per cent. It is procured by decomposing common salt by the joint agency of sulphuric acid and peroxide of manganese. The best proportions are 3 parts of salt and 1 of oxide of manganese; these are well mixed, and put into a retort with 2 parts of sulphuric acid previously diluted with 2 of water. Chlorine is evolved, and its extrication is quickened by the application of a gentle heat. Chlorine may also be obtained from a mixture of muriatic (hydrochloric) acid with half its weight of black oxide of manganese. The gas may be collected over water, and should be preserved in bottles with glass stoppers; if left in contact with water, it is soon absorbed. [MURIATIC ACID.]

Chloriodine or **Chloriodic Acid.** A compound of chlorine and iodine.

Chlorite. A soft mineral of a green colour, often found in cavities and veins in trap rocks. It is a constituent of most of the copper lodes of Devon and Cornwall, and is very common in all the quartz veins in the west of Cork. It is a hydrated silicate of alumina and magnesia, and is known to Cornish miners by the name of *peach*.

Chlorite Schist. A green slaty rock with foliated plates of chlorite and minute grains of quartz, or sometimes with felspar and mica. It passes into gneiss and clay-slate. Chlorite schist is one of a group of rocks having many properties in common. *Talcose Schist* differs from it only by the replacement of talc for mica; and many of the magnesian minerals, as asbestos, diallage, &c. are found with it. Garnets are frequently associated with these schists, and form what is sometimes called a *garnet schist*. All pass occasionally into MICA SCHIST [which see].

Chlorite Slate. The name applied to Chlorite (and Ripidolite) when occurring in mountain masses.

Chloritoïde. A hydrated silicate of alumina and protoxide of iron, occurring in dark grey or greenish-grey folia, at Kosoibrod in the Ural, Bregratten in the Tyrol, Gumuch-Dagh in Asia Minor, and in the mica-schist of Leeds in Canada.

Chlorocarbonic Acid. A compound formed by exposing a mixture of chlorine and carbonic oxide to the action of light.

Chlorochloric Acid. A mixture of chlorous and chloric acids. Mixed with chlorine it forms *Euchlorine*, an explosive gas evolved when a chlorate is heated with hydrochloric acid.

Chlorochromic Acid. Chromic acid in which an equivalent of oxygen is replaced by one of chlorine. It is prepared from common salt, chromate of potash and strong sulphuric acid, and is a volatile red liquid emitting dense suffocating fumes when exposed to the air. Its combination with ammonia is attended by inflammation.

Chlorocyanic Acid. A compound of chlorine and cyanogen.

Chlorodyne. An anodyne remedy, sold under this name, is said to consist of a solution of morphia, extract of Indian hemp, oil of peppermint, &c. in a mixture of chloroform and ether.

Chloroform (Gr. χλωρός, *pale*, and Lat. formica, *an ant*). A compound represented by the formula $C_2\ H\ Cl_3$, and obtained by distilling a mixture of chloride of lime with diluted alcohol. It is a heavy liquid, its sp. gr. being 1·48; it boils at 140°. Its name has reference to the constitution of *formic acid*, which is represented by $C_2\ H\ O_3$, and is therefore the teroxide of a hydrocarbon $= C_2\ H$, to which the term *formyle* has been applied; so that, in reference to this view of its composition, chloroform has also been denominated *terchloride* of formyle. When the diluted vapour of pure chloroform is respired, it soon induces insensibility, in the same way as ether vapour: and hence has been similarly used, in the performance of surgical operations and in childbirth. Much prudence and caution are requisite in its administration; but when pure, and duly diluted with atmospheric air, and in proper cases, it is a safe and very efficient anæsthetic.

Chlorometer. An instrument for the purpose of testing the decolouring or bleaching powers of *chloride of lime*, by which the relative values of different samples of that important bleaching and disinfecting compound may be ascertained. [CHLORIMETRY.]

Chloronitric Gas. Peroxide of nitrogen in which two equivalents of oxygen are replaced by two of chlorine. Yellowish red fumes are evolved when nitrohydrochloric acid is gently heated.

Chloronitrous Gas. Nitrous acid in which an equivalent of oxygen is replaced by one of chlorine. Evolved when nitrohydrochloric acid is boiled.

Chloropal. An amorphous mineral, of a yellowish-green colour, found associated with the Opal of Hungary. It is a hydrated silicate of iron.

Chlorophæite (Gr. χλωρός, and φαιός, *dusky*). A hydrated silicate of protoxide of iron found in the amygdaloid of Scuir More in Rum. The name has reference to the change of colour from green to dark-brown or black, which takes place on exposure in the course of a few hours.

Chlorophæenerite. A hydrated silicate of protoxide of iron of a blackish-green colour, which is found in cavities of amygdaloidal porphyry at Weissig in Saxony.

Chlorophane (Gr. χλωρός, *green*, and φαίνω, *to seem*). A name given to those kinds

of Fluor Spar which, when heated, shine with a beautiful emerald-green phosphorescent light.

Chlorophyll (Gr. χλωρός, and φύλλον, *a leaf*). The green colouring matter of the leaves of plants.

Chlorophyllite. Probably an altered or hydrated variety of Iolite. It occurs at Haddam in Connecticut in large prisms, or in foliated masses, of a greyish or brownish-green colour—usually associated with Iolite in granite. The name has reference to the colour and structure of the mineral.

Chloropicrin. A pungent colourless oil derived from picric acid by the action of chloride of lime.

Chlorosis (Gr.) or **Etiolation.** In Botany, is a species of constitutional debility; the affected plant is pale, and destitute of a healthy green: the stems are weak, long, and slender; no flowers are produced; and the plant is readily killed. This malady is produced or aggravated by bad drainage, or by cold ungenial weather, but is probably dependent mainly on the composition of the soil. The application of a very weak solution of sulphate of iron to the roots has been recommended as a remedy; but it should be accompanied by judicious treatment in other respects. It is artificially produced in celery, endive, sea-kale, and some other esculent vegetables, to destroy their bitter flavour and fit them for the table.

CHLOROSIS. In Medicine, a disease giving a peculiar sallowness to the countenance, hence called the *green sickness*. It chiefly affects young females; its symptoms are extremely various, but generally referable to imperfect or suppressed menstrual evacuation. Tonics, chalybeates, aloetics, sea and cold bathing, and slight electric shocks passed through the pelvis, together with due amusement and exercise, are among the principal remedial agents.

Chlorospinel. A grass-green Spinel from Slatoust in the Ural, in which some of the alumina is replaced by oxide of iron.

Chlorous Acid. An explosive yellowish green gas ($= Cl\,O_3$), evolved when a chlorate, arsenious acid, and nitric acid are heated together.

Chlorous Pole. The voltaic pole or electrode at which chlorine is evolved in cases of the electrolysis of chlorine compounds. It is synonymous with *positive pole*. [ANODE.]

Chloroxalic Acid. A compound obtained by exposing acetic acid and chlorine to bright sunshine. Its elements are in such proportion, that it may be regarded as a compound of 1 equivalent of hydrochloric acid and 1 of oxalic acid.

Chloroxylon (Gr. χλωρός, and ξύλον, *wood*). A genus of *Cedrelaceæ*, known by its fruit having only three cells and splitting into three parts, instead of five. *C. Swietenia*, the satin-wood of India, is a tree of sixty feet high. Extensive imports of the timber are made, the principal uses to which it is applied being for making the backs of brushes, and for turnery ware, the finest pieces being cut into veneers for cabinetmakers.

Chlorurets. Compounds of chlorine. [CHLORIDES.]

Choanites (Gr. χοάνη, *a funnel*). A genus of extinct Zoophytes, so called on account of their fossil skeleton or polypary presenting in general a funnel-shaped figure, though sometimes they are globular or subcylindrical. This genus holds an intermediate place between *Alcyonium* and *Ventriculites*: it is distinguished from the former by having a central cavity at the upper part, and from the latter by not having an outer reticulate surface. One species, the *Choanites Königii*, is found in abundance in the loose flints beneath the turf near the racecourse at Lewes in Sussex, and appears to have been common in the upper beds of the Chalk.

Chocks. On Shipboard, are large wedges of wood driven under the sides of boats, casks, or any curved object, for the purpose of preventing motion when the vessel rolls. *Rudder-chocks* are wedges kept in readiness to stop the motion of the rudder, should any accident render it unmanageable.

Chocolate. A term said to be compounded of two Indian words, choco, *sound*, and alta, *water*, from the noise made in its preparation. Chocolate is made by triturating the roasted cacao-nut into a paste in a heated mortar, sugar and some aromatics being occasionally added; the oily matter of the nut gives it whilst hot a due consistence, so that it is cast in tin moulds, in which it concretes, on cooling, into cakes.

Choir (Fr. chœur, Lat. chorus, Gr. χορός). In Architecture, that part of the church in which the choristers sing the divine service. In former times it was separated from the nave by an ambo or rood screen, in which the epistles and gospels were read, as may still be seen in many of the churches on the Continent, and in the best models in our own country. It was separated from the nave in the time of Constantine. In nunneries, the choir is a large apartment, separated by a grating from the body of the church, wherein the nuns chant the service.

This term is also used in Music, to signify a band of singers in parts, or even the chorus itself.

Choke-damp. A term applied by well-diggers and miners to *carbonic acid gas*.

Cholagogues (Gr. χολαγωγός, *carrying off bile*). Purgatives producing bilious motions.

Choledochus (Gr. χοληδόχος, *containing bile*). One of the ducts of the liver is called the *ductus communis choledochus*.

Choleic and Cholic Acid. Choleic acid is a fatty acid, which, in combination with soda, constitutes a principal ingredient in *bile*. By the protracted action of caustic potash it evolves ammonia, and is converted into *Cholic* acid. The elements of choleic acid are carbon, hydrogen, oxygen, nitrogen, and sulphur, the following being its formula: $C_{44}\,H_{40}\,O_9\,N\,S$.

Cholepyrrhin. The brown colouring matter of human bile.

Cholera (Gr.). A disease accompanied by vomiting and purging, with great pain and debility, and apparently arising from excess or acrimony of bile: it is most common at the close of summer and beginning of autumn, and seems to be produced by cold, suppressed perspiration, indigestible fruits, &c. It generally commences with a sense of pain about the bowels, fever, thirst, an irregular pulse, and severe vomiting and purging of bilious matter: in favourable cases these symptoms subside in a few days with the aid of opiates, mucilaginous diluents, and mild aperients followed by tonics; but in severe cases great exhaustion ensues, attended by depression, anxiety, hurried respiration, cold sweats, hiccup, low and fluttering pulse, and the patients rapidly sink. In such cases warm fomentations sometimes relieve the pain, and effervescent saline draughts check the sickness and enable the stomach to bear large doses of opium.

Cholera, Asiatic. The term *Asiatic* or *Spasmodic Cholera* has been applied to a most appalling form of pestilential disease, which seems to have been but indistinctly known prior to the year 1817. It made its appearance in August that year at Jessore, after having previously raged to a formidable extent in the south of Bengal, and thence it spread over a great part of Asia, carrying off millions of human beings. In 1823 it broke out at Astracan, but did not at that time extend farther into Russia; in 1828, however, it appeared at Orenburg, and during the autumn of that year and the spring of 1829 it spread over a considerable part of the Russian dominions. It raged at Moscow in September 1830; and having been apparently carried by the Russian army into Poland, it propagated itself through different parts of Europe, and reached this country. The symptoms of this, as of other disorders, vary considerably at different times and in different individuals; but as our object here is briefly to describe the characteristic features of the disease in their unalloyed form, we shall omit all unnecessary details, and place before our readers a short account of its effects in its worst and by no means uncommon form.

The first circumstance that strikes us in regard to the attacks of this disease is their suddenness. A person in apparent health feels slightly giddy, chilly, or sick, and in the course of two or three hours sinks into a state of extraordinary and alarming debility; the countenance assumes a deadly paleness, and the skin feels and looks like that of a corpse; the pulse falls, flutters, and is almost imperceptible; a livid circle surrounds the sunken eyes; the tongue is slightly furred, and the breath cold. Under this excessive and extraordinary prostration, the patients sometimes die in the course of a very few hours; otherwise it is succeeded by vomiting and purging, the voided matters resembling turbid whey, being in fact a serous fluid with floating shreds or flocculi of coagulated albumen; and now cramp assails the extremities, and afterwards the abdomen, producing spasms of varying but sometimes of extreme violence; great pain and heat about the region of the stomach, and intolerable weight and anguish round the heart are complained of, with much thirst and anxiety; the voice falters, and the unfortunate sufferer asks frequently, in plaintive and broken whispers, for cold water; the secretions of urine, bile, and saliva appear, in this state of things, as if entirely suspended; the evacuations have a singular fœtor, and the breath and perspiration have that peculiar odour which announces the rapid approach of death. Towards the close of this horrid scene, the respiration becomes very slow, the tendons of the extremities quiver, the sufferer is unable to swallow, insensibility succeeds, and after one or two long and convulsive sobs he dies. The mind, even at last, is scarcely ever much disturbed; but towards the close the patient sinks into a state of apathy, and appears desirous of being left to his fate. Attacks of this kind generally prove fatal in from four to eight hours.

The appearances observed on dissection of those who died within eight or ten hours were: a relaxed and pale state of the stomach and intestines; absence of bile and of fæces in the intestines; an empty and contracted bladder; congestion in the venous circulation of the large vessels; the gall-bladder full of bile, but not passing into the intestine. In more protracted cases other appearances occasionally occurred, more especially serous effusion upon and in the brain, with congestion of the vessels, and other usual appearances of febrile disease. In all cases the blood presents a more or less morbid appearance, and is often of a very dark colour and increased consistence, so as to have been compared to tar.

The pathology of cholera is as yet most imperfectly understood; nor has it been satisfactorily ascertained whether it is or is not contagious; the general opinion, however, is in favour of its contagious nature, and there cannot be the least doubt of the propriety of enforcing the most rigid precautionary measures founded upon such an opinion.

Details respecting the *medical treatment* of cholera would be out of place in this work, and the plans to be pursued vary so much with circumstances, as to render it impossible to condense into small limits a general view of this important subject.

If from this extreme case we turn to what may be termed milder forms of the disease, the same general train of symptoms are observed: but they are less rapid in their succession, and there is more time and opportunity to resort to the resources of art. The attack begins with sickness or purging, succeeded by uneasiness and heat about the pit of the stomach; the matters which are thrown off from the stomach and bowels gradually assume the appearance of rice-water; the countenance shrinks; the con-

striction of the thorax and cramps and spasms follow; and in the course of twenty-four to thirty-six hours the patient dies, in many instances delirious or comatose.

Those who survive seventy-two hours generally recover, as far as the primary symptoms are concerned; the spasms and difficulty of breathing give way, the natural warmth of the body is restored, and the pulse returns to something like its natural standard. The most favourable symptoms are sleep, perspiration, return of the secretion of urine and of bile, accompanied by proportionate improvement in the pulse and aspect of the features; but, even under these apparently and really favourable symptoms, fever of a low or continued character may ensue—it indeed sometimes immediately follows the blue stage or collapse; and, if not relieved by a critical perspiration on the second or third day, the pulse quickens, the face is flushed, there is drowsiness and suffusion of the eyes, stupor, a foul mouth, and other symptoms of mixed or typhus fever, which terminate fatally from the fourth to the eighth day, or even later, in those very individuals who had been saved in the first or cold stage.

Emetics are among the earliest measures which should be put in practice; they should be such as act certainly and rapidly, and conjoined with stimulants, such as essential oils and capsicum. *Blood-letting* has been adopted by many practitioners in the early stages of the disease. Its favourable effect is to cause the pulse to rise; if it produce faintness, it must be immediately put a stop to, and should be followed by the application of warm air, and other dry warmth. Large doses of calomel, with or without opium, are resorted to to remove local congestion, and especially to stimulate the liver; and these means are assisted, and the general powers of the system kept up, by ether, ammonia, brandy, and volatile oils, in such quantities and forms as the particular circumstances of the respective cases may point out. If the irritability of stomach should continue, flannels soaked in very hot water, and then sprinkled with oil of turpentine, should be applied to the region of the stomach and abdomen.

The great object of all those remedies applicable to the first stage of the disease is to enable the system to rally from its depressing effects, to bring about reaction, and to stimulate the nervous and vascular systems; but then the utmost circumspection is required in reference to the injurious effects which this plan will induce, if carried too far. Here, however, the symptoms are usually those of typhoid or continued fever, and are to be treated accordingly, great attention being always paid to the state of the biliary and urinary secretions, and to the evacuations from the bowels.

Besides the treatment founded upon the above outline, other and very dissimilar plans have been adopted, founded upon the change which the blood appears to suffer in this disease. It has been by some presumed that in all cases of cholera the saline matters of the blood, along with a large quantity of its water, are thrown off by the intestines, constituting the characteristic serous discharge above adverted to; and that the residuary blood becomes thick and black, in consequence of the deficiency of its salts. Dr. Stevens therefore proposed the administration of large doses of common salt, occasionally mixed with nitre and chlorate of potash; and from this plan the best effects have, according to some, resulted, while in the hands of others it has entirely failed. The truth is, that in the worst attacks of the disease the approach of death is so quick that there is scarcely time for anything to take effect; and where it is less rapid, the symptoms must guide the treatment: amongst these it must be confessed that there are seldom any which would justify the prudent practitioner in drenching the bowels with salt and water.

But the bolder advocates of what has been termed the *saline treatment* of cholera have gone a step further, and have dared to inject saline solutions into the veins: how far such extraordinary means are justifiable, will appear from the following statement (Pereira, *Elements of Materia Medica*, part i. 313): 'This plan was, I believe, first practised by Dr. Latta. (*Med. Gaz.* x. 257.) The quantity of saline solution which has been in some cases injected is enormous, and almost incredible. In one case 120 ounces were injected at once and repeated to the amount of 330 ounces in twelve hours. In another, 376 ounces were thrown into the veins, between Sunday at 11 A.M. and Tuesday at 4 P.M.; that is, in the course of fifty-three hours, upwards of 31 lbs. The solution used consisted of two drachms of muriate and two scruples of carbonate of soda to 60 ounces of water. It was at the temperature of 108° or 110° Fahr. In another series of cases 40 lbs. were injected in twenty hours; 132 ounces in the first two hours; 8 lbs. in half an hour! The *immediate* effects of these injections, in a large majority of cases, were most astonishing—restoration of pulse, improvement in the respiration, voice, and general appearance, return of consciousness, and a feeling of comfort. In many instances, however, these effects were only temporary, and were followed by collapse and death.'

The reports as to the ultimate benefit of this treatment in cholera, are so contradictory, that it is difficult to form a correct estimate of it. 'That it failed in a large proportion of cases, after an extensive trial, and greatly disappointed some of its staunchest supporters, cannot be doubted. Dr. Griffin states that all the published cases of injection which he can find recorded amount to 282, of which 221 died, while 61 only recovered; but he thinks that the average recoveries from collapse by this method of treatment far exceeded the amount of any other treatment in the same district and under the same circumstances.' (*Med. Gaz.* xxii. 319.)

A vast quantity of matter has been published

in reference to the history, symptoms, and treatment of pestilential cholera. Among those works upon the subject, the general reader may consult the following with advantage; namely, the Reports published by order of government, under the superintendence of the Medical Board; *History of the Epidemic Cholera*, by B. Hawkins, M.D. &c.; Mr. Bell's *Letter to Sir H. Halford*; the Report of Drs. Russell and Barry; Dr. James Copland *On Pestilential Cholera*; and a paper in No. 91 of the *Quarterly Review*, for November 1831.

Cholesterin. The peculiar fatty matter which forms the basis of most gallstones.

Chondrine (Gr. χόνδρος, *cartilage*). That form of gelatine which is obtained from cartilage, and which differs from ordinary gelatine in being precipitable by acetic and the mineral acids, and by sulphate of alumina and potash, persulphate of iron, and acetate of lead.

Chondrodite (Gr. χόνδρος, *a grain*; because of its granular structure). A native silicate of magnesia with part of the oxygen replaced by fluorine and part of the magnesia by protoxide of iron. It occurs in indistinct crystalline masses or embedded grains of a wax-yellow or brown colour, having an occasional but not very decided appearance of regular crystalline form. It is found at Loch Ness in Scotland in granular carbonate of lime, and at Gweedore, county Donegal, in Ireland, in crystalline Dolomite. The largest and most crystalline masses are met with near Sparta in New Jersey, and near Edenville in New York. Other localities are Finland, Sweden, Saxony and the Ural. [HUMITE.]

Chondrology (Gr. χόνδρος, *a cartilage*, and λόγος, *a discourse*). The history of cartilages.

Chondropterygians (Gr. χόνδρος, and πτέρυξ, *a fin*; *gristly-finned*). The name of Cuvier's last order of Fishes, characterised by the gristly nature of all the spines which support the fins. The whole internal skeleton in this order is cartilaginous.

Chonicrite or **Chonikrite** (a word made up from Gr. χώνη, χοάνη, *a melting-pit*, and κριτός, *tested*). A hydrosilicate of alumina, magnesia, and lime, which is found in white irregular masses, with shades of yellow and grey, in the Serpentine of Elba, associated with Pyrosclerite, of which it is probably only a variety.

The name indicates its difference from some allied minerals with respect to fusibility.

Choragic Monument. In Grecian Architecture, this word is applied to a monument raised in honour of the Choragus who, at Athens, was appointed by his tribe to provide a chorus for a play acted at the Dionysia. [LITURGY.] Of the several choragi, he who did his duty best received a tripod, which the victor was bound to exhibit publicly, and for this purpose a building, or column, was erected. The remains of two very fine monuments of this sort, viz. those of Lysicrates and of Thrasyllus, are still to be seen at Athens; they are represented in Stuart's *Athens*.

Chord (Gr. χορδή, *a gut-string*). In Geometry, is the straight line which joins the two extremities of the arc of a curve; so called from the resemblance which the arc and chord together have to a bow and its string, the chord representing the string. The chord of a circular arc is obtained by multiplying the radius by twice the sine of half the angle which the arc subtends at the centre. Tables of chords are given in some of the older works on trigonometry; but they have been superseded by the tables of sines, which are much more convenient for trigonometrical calculations.

Since two circles cannot cut one another in more than two points, they can only have one chord in common. The principle of continuity, however, to the recognition of which the progress of modern geometry is so much indebted, sanctions and suggests a different mode of expression. Circles are curves of the second order, and, as such, are said to intersect in four points; two of these points, however, are alway imaginary and situated on the line at infinity. [CIRCLE.] They are the so-called circular points at infinity. Of the six common chords, then, which two quadrics (e.g. ellipses) in general possess, four are always imaginary in the case of two circles, and two always real. Of these two, however, one is always infinitely distant; the other, which may or may not cut the two circles in real points, is often called their *radical axis*, and possesses many remarkable properties.

CHORD. In Music, a combination of two or more sounds heard together, so as to form harmony. [MUSIC.]

Chord of Curvature. The segment intercepted upon the radius vector to any point of a plane curve, referred to polar coordinates, by the circle of curvature at that point. If r be the radius vector and p the perpendicular from the pole on the tangent, $\frac{p}{r}$ is easily seen to be the sine of the angle subtended, at the circumference of the circle of curvature, by the chord of curvature; so that the latter will be expressed by $2\rho\,\frac{p}{r}$; where ρ is the radius of curvature. In the logarithmic spiral, for instance, where the centre of curvature is always in the perpendicular to the radius vector through the pole, the chord of curvature is always double the radius vector.

Chorda Dorsalis (Lat.). [NOTOCHORD.]

Chorda Tympani (Lat.). A branch of the facial nerve or portio dura, which crosses the tympanum, and supplies the lingualis and some other muscular fibres of the tongue.

Chordæ Vocales (Lat.). In Anatomy, are the ligaments which extend from the thyroid to the cricoid cartilages, and bound the glottis. They contain much elastic tissue, and can be made to vibrate under various degrees of tension by the action of the muscles upon the cartilaginous parts of the larynx to which they are attached; they are the proper organs of voice.

Chorea (Gr. χορεία, *dancing*). The disease commonly called *St. Vitus's dance*. It shows itself by convulsive motions of the limbs, face, head, and trunk, varying extremely in extent and violence; the speech is often more or less affected, and frequently the mental energies become grievously impaired. It is most common in early life, as from the age of ten or twelve to puberty; and makes its approach gradually in persons chiefly of debilitated constitutions: the appetite is generally ravenous at first, and the bowels costive; various convulsive motions then ensue, and only cease during sleep, which, however, is seldom sound. This is one of those diseases which require especial attention in its early stages, and which even in its slightest forms, when once habitual, is very difficult to manage. The leading treatment consists in the judicious administration of aperients and brisk purges, so as to clear the stomach and bowels thoroughly of all irritating matters: the constitution may at the same time be strengthened by tonics and chalybeates, with occasional stimulants; and some of the more urgent spasmodic symptoms may be sometimes cautiously encountered by opium, camphor, henbane, and ether. Cold bathing also has its advantages when circumspectly resorted to; and the mind must be diverted by change of air and scene. The diet should be very regular, nutritive, and never in excess. In this complaint much will depend upon the exertions of the patient himself, who, though relieved of the more urgent symptoms, will often retain relics of his disorder through a long life.

Chorepiscopi (Gr. χωρεπίσκοπος). Country bishops; persons appointed by the bishops in the early periods of Christianity to superintend the rural districts which appertained to their dioceses, but which were at an inconvenient distance from the city in which they abode themselves. The class of chorepiscopi is represented as holding a middle rank between the bishops and the presbyters.

Chorion (Gr.). The external membrane which envelopes the *fœtus in utero*, between which and the amnion there is a gelatinous fluid. Its interior surface is smooth, but externally it is shaggy and vascular.

Chorograph (Gr. χωρογράφος). The name given by the late Professor Wallace, of Edinburgh, to an instrument contrived by him for the mechanical construction of this geodetical problem; viz. 'To determine the position of a station, having given the angles made by lines drawn from it to three other stations in the same plane, whose positions are known.' The problem, which is important from its frequent application in maritime surveying, was reduced by Professor Wallace to another very simple one; viz. 'To construct two similar triangles on two given straight lines, having given their angles.' (Wallace's *Geometrical Theorems and Analytical Formulæ*, &c. Edinburgh 1839.)

Chorography (Gr. χωρογραφία). The description of a district, in contradistinction to geography (the description of the earth or of countries) and topography (the description of particular spots).

Choroid Membrane of the Eye. The second tunic of the eye lying under the sclerotic, with which it has a vascular connection: it commences at the optic nerve, and passes forward with the sclerotic to the beginning of the transparent cornea, where it firmly adheres to the sclerotic by a cellular membrane, forming a white fringe called the *ciliary circle*; it then recedes from the sclerotic and cornea, forming a round coloured disc called the *iris*, and its posterior surface is termed *uvea*. The choroid membrane is very vascular, and its external stellated vessels are called *vasa verticosa*. Its internal surface is covered by a *black pigment*.

Choroid Plexus. A plexus of blood-vessels situated in the lateral ventricles of the brain.

Chorus (Lat.; Gr. χορός). In the Greek theatre, a band of singers and dancers who sang the odes introduced into the drama. The chorus played an important part in the Greek tragedies and early comedies. The duty of furnishing these Choruses was one of the three Liturgies or public burdens imposed on the richest private citizens of Athens. [LITURGY.]

The term is used in modern Music for a vocal composition in which each part is sung by many voices together. The word is also applied to the body of the singers themselves.

Chose (Fr. *thing*, from Lat. causa) **in Action.** In Law, is defined to be personal property whereof the owner hath not the possession (in the technical sense), but only a right of action to recover it; as, a debt on bond or covenant.

Chouans. In French History, the royalist insurgents on the right bank of the Loire during the Revolution, when the Vendeans rose on the left, were thus popularly named; according to some, from the cry of the screech-owl (*chat-huant*), an imitation of which was a signal during their nightly meetings. They were for the most part brigands, and their object rapine rather than civil war. After the Revolution of 1830, they made a transient reappearance in the neighbourhood of Nantes and Le Mans.

Chrematistics (Gr. χρηματιστική). The science of wealth; a name given by Continental writers to the science of political economy, or rather to what in their view constitutes a portion of the science. They consider *political economy* as a term more properly applicable to the whole range of subjects which comprise the material welfare of states and citizens, and *chrematistics* (by which they mean nearly the same science which M'Culloch and most other English writers describe as political economy) as merely a branch of it. See especially M. de Sismondi, *Études sur l'Économie Politique*. [CHRYSOLOGY.]

Chrestomathy (Gr. χρηστομάθεια). According to the etymology, that which it is useful to learn. The Greeks frequently formed commonplace books by collecting the various passages to which, in the course of reading, they had affixed the mark χ (χρηστός). Hence books of

extracts chosen with a view to utility have received this name.

Chrism (Gr. χρῖσμα, from χρίω, *I anoint*). The oil which is used both in the Greek and the Romish churches in the administration of baptism, confirmation, ordination, and extreme unction.

Chrismatine. A mineral resin found in the coal formation at Wettin, near Halle.

Christ (Gr. χριστός, *anointed*, answering to 'Messiah' in Heb.). The name given as a title of eminence to the Lord Jesus, whom, in the words of St. Peter (Acts x. 38), 'God anointed,' as king, priest, and prophet, 'with the Holy Ghost and with power.'

Christendom. A word sometimes employed in such a sense as to comprehend all nations in which Christianity prevails; more commonly all realms governed under Christian sovereigns and institutions. Thus European Turkey, although three-fourths of its inhabitants are Christians, is not in ordinary language included within the term *Christendom*. The history of the fortunes of Christianity, in respect of its geographical extension, presents remarkable periods of advance and decline. After the conversion of Constantine, and the gradual decay of Paganism, Christianity continued to spread, but chiefly in the direction of east and south, for more than three centuries, the barbarian conquerors of the Roman provinces soon adopting it. About the middle of the seventh century, Christendom comprehended Europe south and west of the Rhine and Danube; Africa north of the Great Desert; Abyssinia; parts of Nubia; Asia to the Euphrates; Armenia, and part of Arabia; and that small colony in Southern India which subsists to this day. The Saracen power rose, by conquest, from this extensive empire. In little more than a century Christendom was deprived of nearly all its Asiatic provinces, of which the faithful inhabitants were reduced to a tributary condition; of the whole of Northern Africa, in which they were exterminated or converted; and of Spain. Sicily, the latest conquest of the Saracens, was occupied by them about 830. But just at the same epoch, or that of lowest decline, Charlemagne began to extend the limits of Christendom in the north; and the second period of advance extends through the ninth, tenth, and eleventh centuries, in which 'the reign of the gospel and the church was extended over the north: Bulgaria, Hungary, Bohemia, Saxony, Denmark, Norway, Sweden, and Russia.' (Gibbon, chap. lv.) From that time to the sixteenth century, Christianity gradually reconquered Spain on the one hand; while, on the other, the newly arisen power of the Turks wrested from it the remainder of its Asiatic territories and the European provinces of the Greek empire. Since that period no important changes have taken place in the relative extent of Christendom and Islamism; but the vast continent of America, as far as it has been colonised, has been added to the former, and the rapid increase of its communities in numbers and civilisation has greatly enhanced their comparative importance. The number of Christians inhabiting Europe and America, and scattered in the other parts of the globe, may perhaps be estimated conjecturally as follows:—

Roman Catholic church	180,000,000
Reformed churches	80,000,000
Greek and other Oriental churches	70,000,000
	330,000,000

If we estimate the number of Christians at 300 millions, one half perhaps of this amount may be assigned to the Roman Catholic church, and the other half nearly equally divided between the various Reformed churches on the one hand, and the Greek and other Oriental communities on the other.

Christianite. The name given by Monticelli to the Anorthite of Vesuvius, in compliment to Prince Christian of Denmark. The same name has also been given by Des Cloizeaux to the Harmotome from Stempel, near Marburg.

Christianity. The religion of Jesus Christ. From the period when the disciples 'were called Christians first in Antioch' (Acts xi. 26) down to the present day, the main doctrines of the gospel, and the great moral principles which it reveals and confirms, have been preserved without interruption in the church. But notwithstanding this substantial unity, it cannot be denied that the character of the religion has been very materially coloured throughout all its history by the circumstances and genius of different nations and ages. The first marked forms of opinion which acquired consistency among the general body of Christians tended in two very different directions. The *Judaising* Christians clung to the ordinances of the elder religion; but although under the names of Nazareans &c. they existed as late as the fourth century, they ceased after the first to exercise any very extensive influence on the church. The *speculative* Christians placed figurative interpretations both on the external facts and mysteries of the religion, or sought to connect it with the philosophical and theurgical systems of the ancient world. Apollos of Alexandria was the first teacher, it is commonly said, who introduced this speculative tendency into Christianity; and St. Paul, while he does not condemn Apollos, dwells on the evils produced by those who from his teaching deduced as it were a separate body of doctrine (1 Cor. iii.). In this way arose: 1. The early heretics, the Nicolaitans and followers of Cerinthus, and the Gnostics, professors of the 'knowledge falsely so called' (ψευδώνυμος γνῶσις) of St. Paul. 2. At a later period, the Manichæans, who imported into Christianity the notion of the rival principles of good and evil, which continued for many ages to possess adherents. 3. Within the church itself, the *Alexandrian school of theology*, which has exercised a more permanent influence. This school, in the second and third centuries

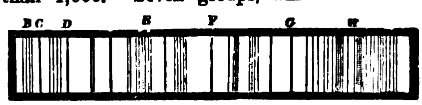
became partially tinged with the sentiments of Platonic philosophy; and was characterised by the acute and refining spirit of the East. Like the Gnostics, its chief doctors encouraged the notion of a mystical or second meaning in the revelations of the faith, of which the key was in the possession of the learned only (Clemens, Origen, &c.). In the meantime, the main body of believers, comparatively unaffected by the influence of science and speculation, was gradually acquiring new views of a different and more positive character. During the first three centuries after the apostolical times, the opinions respecting the authority of the priesthood, the attachment to forms and ordinances, the honour paid to individual purity of life (and especially to constancy under persecution), gradually and steadily increased and strengthened. In the West, and particularly in Africa, these tendencies became peculiarly strong. The Montanists, Donatists, and Novatians separated successively from the church, on the score of its defection from an imaginary standard of personal purity; and when Africa began to have a school of theology of her own (Tertullian, Cyprian, and others, to Augustine), this was the direction of its labours. In that theology all is dogmatical, nothing speculative. Everything is taken in its most literal and naked sense: God himself is not personal only, but invested almost with the attributes of a human agent. Both doctrines and ordinances are as definite as possible, and the utmost rigour of practice enjoined. The history of the African church affords a momentous commentary on these strainings after imaginary perfection. After two centuries of discord and decay from the time of Augustine, it was not only subdued but obliterated by the first assault of the Mohammedans. The early heretics had entertained theoretical notions respecting the inferiority of Christ to the Father; but the Arians, in the last half of the third century, were the first to preach it as the doctrine of the church, and to seek to confirm it by appeal to antiquity. The council of Nice (A.D. 325) condemned this opinion; but the Arians and other sects differing from the church by various shades of opinion on the same subject, continued to subsist until the sixth century, during which these controversies partly died away in the West, amidst the misery and barbarism of the age, and partly were extinguished by the authority of the church. It was thus that the governors of the church were first driven to protect its fundamental doctrines by reducing them to formal propositions embodied in creeds and the canons of councils (especially the six oecumenical or general, which were held from A.D. 381 to 680).

From this period, the history of Christianity embraces that of the separation of the Eastern and Western churches, A.D. 716 to the eleventh century; that of the Western reformation, which may be said to commence with the sectaries of the thirteenth century and end with the establishment of Protestantism in the sixteenth; that of the struggle with Mohammedanism; of foreign missions; and of internal developement—all too voluminous for anything more than reference.

Chromatic. In Music, a term referring to the alteration of a note by applying to it a sharp or a flat.

Chromatics (Gr. χρωματικός). That part of Optics which treats of the colours of light and of natural bodies. This is a very important branch of physical science, and one which of late years has been prosecuted with great assiduity. Until Newton undertook his memorable experiments on the refraction of light, the cause of the different colours of bodies had never received any satisfactory explanation: such, indeed, was the difficulty which the ancients attached to this subject, that Plato considered it to be a usurpation of the rights of the Deity to attempt the investigation of this mystery of nature. The discovery of the difference of refrangibility in the coloured rays of the solar spectrum afforded a clue to the solution of the problem; and Newton demonstrated, by a series of decisive experiments, that colour depends not on any modification of light acquired by reflection or refraction, but is inherent in the light itself; the solar beam being composed of rays of all the colours contained in the spectrum, which are differently affected in passing through refracting media.

When a pencil of white light is decomposed by a prism [Spectrum Analysis], the spectrum, or many-coloured band of light, thus produced is found on minute examination to contain a great number of dark lines, or fixed rays, parallel to one another and perpendicular to its length. These dark lines were first perceived by Dr. Wollaston; but it was Fraunhofer, a celebrated optician of Munich, who first accurately described the phenomenon, and pointed out the uses to which it could be applied. They are distributed very unequally through the spectrum, and the whole number amount to more than 1,000. Seven groups, which are more



easily perceived than the others, and which are distributed over the principal colours of the spectrum, have been distinguished by Fraunhofer by the letters B, C, D, E, F, G, H. Of these B is in the red space, near its outer end. C, which is a single line, and blacker than others contiguous to it, is near the limit of the red, next the orange. D is in the orange, and near the yellow; it is composed of two lines of equal darkness, very close to each other, and is easily distinguished. E is in the green, and consists of seven or eight rays. F is in the blue, G in the indigo, and H in the violet. Besides these, there are several other very remarkable groups, particularly one in the green, between E and F, which is composed of three strong lines. These lines always preserve

the same relative positions in respect of the boundaries of the coloured spaces; and though their distances vary with the nature of the prism by which they are produced, their number and order remain absolutely invariable so long as the light proceeds from the same source. This fixedness of position greatly facilitates the expression and communication of the results of chromatic researches. Professor Kirchhoff has recently made the important discovery that many of these dark lines in the solar spectrum are exactly coincident in position with the bright lines forming the spectra of the light emitted by ignited metals, and has artificially produced dark lines by absorbing the light evolved from a given ignited metal, by the heated vapour of the same metal. The irresistible conclusion is, that this absence of solar light which is spoken of as 'the dark lines of the spectrum,' is due to absorption of light emitted from the solid or liquid nucleus of the sun by the vapour of metals existing in the sun's atmosphere. In this way Kirchhoff's experiments indicate that iron, calcium, magnesium, sodium, nickel, and probably some other terrestrial metals, are constituents of the sun; while gold, silver, mercury, aluminium, cadmium, tin, lead, antimony, arsenic, strontium, and lithium are either absent or not present in sufficient quantity to produce an appreciable absorptive effect. It would therefore seem that the phenomenon of Fraunhofer's lines is due to the reversal, the negatives so to speak, of associated or superimposed spectra.

Colours of Natural Bodies.—Newton proved that the colour of any body is not the result of any quality inherent in that body, or in the particles by which it may be tinged, but is merely a property of the light in which they happen to be placed. The peculiar colours of bodies are only exhibited in a white light. If they are viewed by the simple and homogeneous light of any colour, they either appear black or of the colour of that light and no other. Hence we conclude that one body is red, and another violet, because the one is *disposed* to reflect the red or least refrangible rays, and the other the violet or most refrangible. The ordinary phenomena of colours may be explained on the principle of absorption. Every substance, how opaque soever it may be, transmits light, at least through a very small thickness; thus gold when reduced into thin leaf is translucent. From this fact it is assumed as a principle, that every particle of ponderable matter has the faculty of absorbing or extinguishing a determinate fraction of the luminous rays which fall on it or pass very near it, the remainder being reflected or transmitted. This fraction varies with the colour or species of colour of the incident luminous rays; and with the nature of the particle. For light of the same colour we may suppose it constant, whatever be the number of incident rays; so that the intensity of a homogeneous light, which has traversed a diaphanous plate composed of equidistant particles of the same nature, will diminish in a geometrical, when the thickness of the plate increases in an arithmetical, progression. White light falling on the surface of an opaque body is not totally reflected at the surface, for, as has been just remarked, no substance is perfectly opaque: a portion of the incident light therefore penetrates the superficies of every body on which it falls, and is reflected by particles beneath the surface; and, in consequence of this interior reflection, is again emitted from the medium. But whilst the ray is thus penetrating and escaping from the body, the different colours of which it is composed suffer unequal absorptions; and on the totality of these absorptions depends the compound colour of the reflected ray, or the natural colour of the body. In this manner are explained the effects produced by coloured glasses, the blue colour of the sky, and the various tints of great masses of water.

For an explanation of the phenomena of the colours of thin laminæ, as soap bubbles, plates of mica, and of striated and grooved surfaces, see INTERFERENCE; LIGHT; REFRACTION.

Chromatic Scale. [SCALE.]

Chromatic Semitone. [SEMITONE.]

Chromatic Thermometer. When the edge of a rectangular plate of glass is applied to a piece of heated metal, or other substance having a temperature different from that of the glass, and exposed to a beam of polarised light, coloured fringes are developed; and as the particular tints depend on the difference between the temperature of the glass (which is supposed to be known) and that of the substance to which it is applied, the colour of the central fringe affords a means of inferring approximately the temperature of the substance. Hence the term *Chromatic Thermometer.*

Chrome Alum. The potassa-sulphate of chromium; a salt isomorphous with alum, in which alumina is replaced by oxide of chromium.

Chrome Chlorite. Hermann's name for a fibrous kind of Kammererite of a reddish-blue colour.

Chrome Mica. The name given by Breithaupt to an emerald-green Mica from Schwartzenstein in the Zillerthal.

Chrome Ochre (Gr. χρῶμα, *colour*). A substance found in earthy masses of a green or yellowish-green colour, in Unst, one of the Shetlands, filling small fissures in chromate of iron.

Chrome Orange. Formed on boiling yellow chromate of lead with lime. It is a dichromate of lead, and is a well-known pigment.

Chrome Stone. The name sometimes given to Chrome Ochre when it is so intimately mixed with the rock as only to be separated from it by chemical means. The ochre found between Conches and Creuzot in France, at Waldenberg in Silesia, and at Mortenberg in Sweden, is of this description.

Chrome Yellow. The yellow chromate of lead.

Chromic Iron or **Chromite.** A mineral composed chiefly of the oxides of chromium and

iron; a chromite of iron. It occurs crystallised in octahedrons, but commonly massive and disseminated in black grains. It is found in abundance in Unst and Fetlar in the Shetlands, as well as in some of the other smaller islands; also near Portsoy in Banffshire. It is also found at Gassin (Dépt. du Var) in France, in Saxony, Silesia, Styria, Hungary, Bohemia, Norway, Ceylon, and in large masses near Ekatherinenberg in the Eastern Ural, and at Tenos in Greece. It is the most abundant ore of chromium.

Chromium (Gr. χρῶμα, *colour*). A metal discovered by Vauquelin in 1797. It exists chiefly in two native compounds; the one formerly called *red lead* of Siberia, which is a *chromate of lead*; the other the compound of the oxides of chromium and iron. Chromium is a whitish, brittle, and very infusible metal (sp. gr. 5·5). When heated with nitre it is converted into *chromic acid*. Its equivalent number is 28. It forms two compounds with oxygen—a green oxide and a red peroxide; the latter being sour, and combining with salifiable bases, is called *chromic acid*. The oxide consists of 28 chromium + 12 oxygen; and chromic acid of 28 chromium + 24 oxygen. Chromic acid is of a red colour, and forms a variety of *coloured* compounds, some of which are much used in the arts; such as the *chromate* and *bichromate of potash*, largely manufactured for the use of calico printers, and the *chromates of lead*, employed as yellow and red dyes and paints. The oxide of chromium is green, and furnishes a valuable colour for porcelain and enamel. Chromic acid gives colour to the ruby, and the green of the emerald is due to oxide of chromium.

Chromo-lithography. [LITHOGRAPHY.]

Chromohydrocyanic Acid. A body analogous to ferrihydrocyanic acid or ferridcyanogen, but containing chromium in the place of hydrogen. It forms salts with positive elements.

Chromotartaric Acid. This body is conveniently described as bitartrate of chromium, but it really is an acid body and forms salts with bases.

Chromoxylography. In Printing, the art of producing coloured pictures by ordinary letter-presses from wood blocks, each colour having a block of its own and requiring a separate impression. Rainbow tints are formed by *braying out* various coloured inks so that the edges of each of the colours where they touch are as faint as possible.

Chromule (Gr. χρῶμα, *colour*). The green colouring matter of the leaves of plants; more commonly and properly termed *Chlorophyll*.

Chronic (Gr. χρονικός; from χρόνος, *time*). Diseases of long duration are termed *chronic*, in opposition to those of more rapid progress, which are called *acute*.

Chronicle. In Literature, an historical register of events in the order of time. Most of the historians of the middle ages were chroniclers who set down the events which happened within the range of their information, according to the succession of years.

Chronicles. The name of two books in the canon of Scripture. They consist of an abridgment of sacred history from its commencement down to the return of the Jews from the Babylonish captivity, and are called by the Septuagint παραλειπόμενα (lit. *things omitted*), because they contain many supplemental relations omitted in the other historical books. It has been supposed by Eichhorn and many other writers that the Chronicles were compiled by Ezra, though circumstances are not wanting to diminish the probability of this conjecture.

Chronogram (Gr. χρόνος, *time*, and γράφω, *I describe*). An inscription comprehending a date, which may be read by selecting all or some of the numeral letters, which are frequently written in these curious trifles in larger characters than the rest; as,

'ChrIstVs DVX ergo trIVMphVs.'

(A medal of Gustavus Adolphus.) Sometimes united with an anagram; as one in honour of General Monk,

'GeorgIVs MonCe DVx de AumarLe;'

which may be read,

'Ego Regem reduxi, Ano. Sa. MDCLVV.'

Chronology (Gr. χρονολογία). The science which treats of the various divisions of time, and of the order and succession of events.

In order to ascertain and register the intervals of time between different events, two things must necessarily be assumed: *first*, an epoch or fixed point in time to which all events, whether preceding or succeeding, may be referred; and *secondly*, a measure or definite portion of time, by which the intervals between the fixed epoch and other events may be estimated. Of these the first is entirely arbitrary, and the second arbitrary to a certain extent; for though certain periods are marked out by the recurrence of natural phenomena, a choice of these phenomena must be made. It is on account of the arbitrary nature of these two elements, on which all chronological reckoning depends, that so much confusion and uncertainty exist respecting the dates of historical events.

The diversity of epochs which have been assumed as the origin of chronological reckoning, is a natural consequence of the manner in which science and civilisation have spread over the world. In the early ages the different communities or tribes into which mankind were divided began to date their years each from some event remarkable only in reference to their own individual history. Hence not only different nations, but almost every individual historian or compiler of annals, adopted epochs of their own. Events of local or temporary interest were also constantly occurring in every community which would appear of greater importance than those which were long past, and consequently be adopted as new historical dates. The foundation of a monarchy or a city, or the accession of a king, were events of this class, and accordingly are epochs of frequent occurrence in the ancient annals.

Religion also came in to increase the confusion caused by political changes. Soon after the introduction of Christianity, the various sects began to establish eras, commencing with events connected with the appearance of Christ; but no regard was given to uniformity. In like manner, the Mohammedans employ dates having reference to the origin of their faith. All these circumstances have conspired to render it a task of extreme difficulty for modern historians to ascertain the order of the political occurrences of ancient times.

But it is not merely the number of chronological epochs and the various origins of eras that have caused the perplexity; the measure by which long intervals were compared varied in different countries and in different ages; hence arises another source of confusion in arranging the order of time. In the Scripture history the lapse of time is frequently estimated by generations or reigns of kings. Some of the historians of early Greece reckoned by the succession of the priestesses of particular temples or cities; others by that of the ephori of Sparta; and others again by the archons of Athens. (Thucydides ii. 2.) Even when the length of the solar year began to be used as the measure of time, uniformity was not obtained. The length of the solar year is a fixed element in nature, and liable to no variation; but neither the commencement nor termination of the year is marked by any conspicuous sign. Its precise length can only be ascertained by a long-continued series of astronomical observations. Rude nations were therefore unacquainted with it; and even when it had become known with considerable accuracy, it was still necessary to form a civil year, and adapt it to the seasons, the solar year not being composed of an exact number of days. Most nations had recourse to intercalations [CALENDAR] for this purpose. The ancient Egyptians followed a purely solar year, which consisted of exactly 365 days. Its commencement, therefore, fell one day earlier with respect to the seasons every four years, and in the period of about 1,460 years would successively fall on every day in the year, and a whole year be gained in the reckoning. The civil year of the Jews, the Greeks, and many other nations, was regulated partly by the sun and partly by the moon, which rendered its adjustment still more complicated and difficult. (Sir G. Lewis, *Astronomy of the Ancients*, ch. i.) The Mohammedan year is purely lunar; and we can only pass from their calendar to the *Gregorian*, which is used in Christian countries, by first finding the number of days from the commencement of their era to any given event, and then turning them back into Gregorian years. [HEGIRA.] The Chinese, Hindus, and some other Asiatic nations, have epochs and methods of reckoning peculiar to themselves.

For these reasons, and numerous others that might easily be adduced, it is very seldom that the precise interval between the events mentioned in ancient history and modern dates can be determined with any degree of certainty, and great discrepancies exist among the computations of different chronologers. A remarkable instance of this occurs with regard to the computations made to determine the epoch of the creation of the world from the Scripture history. Desvignoles, in the preface to his *Chronology of Sacred History*, mentions that he had collected upwards of 200 different calculations, the shortest of which reckons only 3,483 years between the creation and commencement of the common era, and the longest 6,984; the difference being no less than thirty-five centuries. The most important works on chronology are—Usher's *Annales Veteris et Novi Testamenti*; Newton's *Chronology*; Blair's *Chronology and History of the World*; Playfair's *Chronology*; *Tables Chronologiques de l'Histoire Ancienne et Moderne*, by Thouret; Clinton's *Fasti Hellenici*; and above all others, *L'Art de Vérifier les Dates*.

Chronometer (Gr. *χρόνος*, *time*, and *μέτρον*, *measure*). A watch of peculiar construction, and great perfection of workmanship, used for determining geographical longitudes, or other purposes where time must be measured with extreme accuracy. The chronometer differs from the ordinary watch in the principle of its escapement, which is so constructed that the balance is entirely free from the wheels during the greater part of its vibration; and also in having the balance compensated for variations of temperature. Marine chronometers generally beat half-seconds, and are hung in gimbals, in boxes about six or eight inches square. The pocket chronometer does not differ in appearance from the ordinary watch, excepting that it is generally a little larger. Chronometers are of immense utility in navigation, and ships going on distant voyages are usually furnished with several, for the purpose of checking one another, and also to guard against the effects of accidental derangement in any single one. The accuracy with which chronometers have been found to perform is truly astonishing; the error in the mean daily rate in a two months' voyage sometimes not exceeding two or three seconds.

Chryodine. A dark-violet matter formed when sulphuric acid acts upon chrysammic acid.

Chrysalis (Gr. *χρυσαλλίς*, from *χρυσός*, *gold*). The second state of a Metabolian or changeable insect, in which it becomes inactive, takes no food, and is enclosed in a transparent covering, which in many instances reflects a metallic lustre; whence the name.

Chrysamide. Bronze-coloured crystals obtained on boiling chrysammic acid with solution of ammonia.

Chrysamidic Acid. Olive-green crystals deposited from a boiling solution of chrysammic acid in dilute hydrochloric or sulphuric acid.

Chrysanilic Acid. A bluish red precipitate formed when an acid is added to a solution of indigo in potash.

Chrysanisic Acid. Small golden scales resulting from the action of hot fuming nitric acid on nitranisic acid.

Chryselephantine (Gr. χρυσελεφάντινος, from χρυσός, *gold*, and ἐλέφας, *ivory*). A name given by Greek sculptors to those statues which were overlaid with ivory and gold. The most celebrated of these was the colossal statue of Athênê, the work of Phidias in the age of Pericles. The gold of this statue was plundered by Lachares, and the statue itself was afterwards taken by order of Justinian to adorn the Hippodrome of Byzantium. We are therefore left to the description of Pausanias, and to the figures engraved on some medals, in order to determine the general character of works of this class. This uncertainty has given rise to some sharp controversy. An attempt to restore the great statue of Phidias has been made by M. Beulé, at the cost of the duc de Luynes, but the faithfulness of the restoration has been questioned by M. Alphonse de Calonne. (*Edinburgh Review*, July 1859, art. 'Acropolis of Athens,' p. 57.)

Chrysobalanaceæ (Chrysobalanus, one of the genera). A natural order of shrubby or arborescent Exogens, chiefly inhabiting the hotter parts of the world. They are very nearly related to *Rosaceæ*, from which they differ in having a style proceeding from the very base of the ovary, and irregular stamens and petals. The species are of little importance. The fruit of *Chrysobalanus Icaco* is eaten in the West Indies under the name of the Cocoa Plum, and that of some others is used in other countries in a similar way.

Chryseberyl (Gr. χρυσός, and βήρυλλος, *beryl*). An aluminate of glucina, composed of 80·2 per cent. of alumina and 19·8 of glucina. It occurs in small rounded masses about the size of a pea, but sometimes crystallised in eight-sided prisms with six-sided summits which are transparent or translucent, very hard, and of various tints of greenish-yellow, sometimes with a bluish opalescence internally. It is found in Ireland in the granite of the Mourne Mountains, and at Glenmalure, county Wicklow, but it is principally obtained in Brazil and Ceylon from the alluvial deposits of rivers. Though not much employed in jewellery, the Chrysoberyl sometimes forms a beautiful stone almost equal in appearance to the yellow diamond. The Chrysoberyl of the ancients was a different stone, probably the Chrysoprase of the moderns.

Chrysochlore (Gr. χρυσός, and χλωρός, *pale green*). A species of mole, *Chrysochloris capensis*, inhabiting the Cape of Good Hope, the fur of which reflects most brilliant metallic hues of green and gold.

Chrysocolla (Gr. χρυσόκολλα). A hydrated silicate of copper. The colour is verdigris or emerald-green, passing into sky-blue, and inclining to brown when impure; with a shining or dull resinous lustre, and opaque or only slightly transparent.

It occurs stalactitic, and massive, but oftener investing Malachite and other ores of copper. It is found in Cornwall, in Cumberland, Westmoreland, Isle of Man, Leadhills in Scotland, Knockmahon and Audley mines in county Cork; also in Bohemia, the Banat, Hungary, Austria, the Tyrol, Saxony, the Harz, Siberia, Mexico, Chili, South Australia, &c.

The name Chrysocolla was given to this mineral by the ancients, because it was employed, along with silver and gold, in the soldering of the latter metal.

CHRYSOCOLLA. The Greek name for borax.

Chrysography (Gr. χρυσογραφία). The art of writing in letters of gold: a sumptuous fashion, practised by the writers of manuscripts, chiefly in the early part of the middle ages, when the leaves of parchment which contained the writing were also dyed with purple and other colours.

Chrysolite (Gr. χρυσόλιθος). The name applied to the paler and more transparent kinds of Olivine. It rarely occurs crystallised, but generally in angular or rolled pieces of a greenish or golden-yellow colour, embedded in basalt or lava. The principal localities are Vesuvius and the Isle of Bourbon, in lava; Real del Monte in Mexico, Upper Egypt, Constantinople, and in pale-green transparent crystals amongst the sand of a stream at Expailly in Auvergne. It is a silicate of magnesia and iron, and is sometimes used in jewellery. The stone called Chrysolite by the moderns is supposed to have been the Topaz of the ancients.

Chrysology (Gr. χρυσός, and λόγος, *discourse*). A name by which some Continental writers distinguish that branch of political economy which relates to the production of wealth.

Chrysomela (Gr. χρυσός, and μέλας, *black*). The name of a Linnæan genus of Coleopterous insects, now the type of an extensive group, divisible into three families; viz. the *Chrysomelidæ* proper, characterised by having the antennæ remote from each other at the base; *Cassididæ*, having the antennæ arising close together, but concealed at the base by the thorax; and *Galeracidæ*, having the antennæ close together at the base, but not concealed by the thorax. The characters which these three families possess in common are, a small body of an oval or rounded form; antennæ seldom so long as the body; legs of a moderate length, but rather thickened; and tarsi with the three basal joints dilated and spongy beneath, forming a kind of cushion. The insects of the present tribe are of sluggish habits, and feed upon the leaves of various vegetables, both in the larva and imago state, being characterised in the latter period by their brilliant metallic tints; whence their name. The larva of one of the British species (*Eumolpus vitis*, Fabr.) preys upon the young buds and leaves of the vine, and by its attacks upon the footstalk of the grape bunch so injures the nutrient vessels, as to cause the destruction or deterioration of the fruit. In the wine countries of Europe the

ravages of this insect are often very serious, and much dreaded.

Chrysomelane. [PLEONASTE.]

Chrysopal (Gr. χρυσός, *gold*, and Opal). [CHRYSOBERYL.]

Chrysophanic Acid. *Rhaponticin, Rheic acid, Rhein, Rheumin, Rhubarbaric acid, Rhubarbarin, Rumicin.* The colouring matter of various species of rhubarb and parmelia. It forms golden-yellow crystals.

Chrysoprase (Gr. χρυσόπρασος). An apple-green or leek-green variety of Chalcedony, found at Kosemütz in Lower Silesia, embedded in Serpentine, and at Belmont's lead mine, St. Lawrence county, North America. The colour is caused by oxide of nickel. It is much esteemed (on the Continent especially) as an article of jewellery, and is probably the stone called Chrysoberyl by the ancients.

Chrysorhamnin. The colouring matter of Persian berries. It occurs in acicular crystals.

Chrysotil. A fibrous variety of Serpentine, produced by the alteration of other minerals; Asbestos, Actinolite, Bronzite, &c. The colour is that of olive-oil, yellowish or brownish, with a metallic or silky lustre. It has been found in Anglesey, at Reichenstein in Silesia, and at New Haven in Connecticut.

Chunam. The name of a white cement, extensively used in the East Indies from the earliest period. It appears to owe its properties to the thorough hydration of all the parts of the mass; and in the interior of the country is said to be composed of a gravelly kind of limestone mixed with sand; but along the coast it is composed of shell lime and sea sand, mixed with 'jaggree,' or sugar water, which can only set on the condition that the ingredients are closely in contact with one another, and if the hydration has been effectually performed. Another kind of chunam is used for plastering, and takes a high polish; it consists of shell lime (without sand), yolks of eggs, and jaggree, beaten together with water in which the husks of cocoa-nuts have been steeped.

Church (possibly from the Gr. κυριακόν, from κύριος, *lord*; but this derivation is very doubtful). This word is used in various significations, answering to those of the Greek ἐκκλησία (Fr. église), which, from its original meaning of a *convened assembly*, is employed, 1st, to denote the whole body of true believers, or the visible church; 2nd, in addition to these, the spirits of the just made perfect, or the invisible church; 3rd, any congregation of Christians met together in a single place, or the body of believers resident in a town or district; and 4th, the edifice in which they meet for divine worship. To these we may add a fifth sense of the modern term *church*, when it is applied to a distinct religious community; as the Romish, the English, the Lutheran, &c. The true definition of the visible church has been a matter of much controversy. The English church, in her nineteenth article, explains it to be 'a congregation of faithful men, in which the pure word of God is preached, and the sacraments duly administered, according to Christ's ordinance, in all those things that of necessity are requisite to the same.' What these necessary requisites are is not dogmatically laid down, whence many communities come to be comprehended in the visible church by English divines which the Romish and other authorities exclude. Many sects, however, extend the pale still further, not considering the reception of the sacraments as any test of churchmanship, but referring it solely to the earnest belief and moral conduct of individuals.

CHURCH. In Architecture, a building dedicated to the performance of Christian worship. Under the article ARCHITECTURE, an account is given of the basilicæ which were first used for the assembly of the early Christians for this purpose, to which the reader is referred. Among the first of the churches was that of St. Peter's at Rome, erected about 326, nearly on the site of the present church; and it is supposed that the church of St. Sophia at Constantinople was built somewhat upon its model. That which was afterwards erected by Justinian seems, in its turn, to have served as the model for St. Mark's at Venice, which was the first church constructed in Italy with pendentives and a dome; the former furnishing the means of covering a square plan with a hemispherical vault. The five most celebrated churches in Europe erected since the period known as the Renaissance are: St. Peter's at Rome, which stands on an area of 227,069 feet; St. Maria dell' Fiore at Florence, which stands on 84,802 superficial feet; St. Paul's, London, which stands on 84,025 superficial feet; St. Isaac's, Petersburg, which stands on 68,845 superficial feet; and St. Geneviève, Paris, which stands on an area of 60,287 superficial feet. The churches are usually classed as follows in all countries where distinctions are recognised in them: *pontifical*, as St. Peter's at Rome, where the Pope occasionally officiates; *patriarchal*, where the government of the church is vested in a patriarch; *metropolitan*, when it is the see of an archbishop; *cathedral*, where a bishop presides; *collegiate*, when the building in question is attached to a college; *parochial*, when it is attached to a parish; and *conventual* when it is attached to a convent.

Chusite (from the Greek χέω, *to pour* or *fuse*; from its fusibility). An altered Chrysolite found in small yellow masses in the basalt of Limbourg.

Chyazic Acid. From the initials of *carbon, hydrogen* and *azote*. A term applied to the compounds of hydrocyanic acid.

Chyle (Gr. χυλός). The nutritious fluid prepared from the chyme, and imbibed by the lacteals to be conveyed to the thoracic duct and venous system. It contains about 10 per cent. of solid matter. In most mammals it is white; in birds transparent, except in some that live on ants and insects, as the woodpecker, which has been observed to be opaque; it is white in

the crocodile, but colourless and transparent in other reptiles and in fishes.

Chyle-corpuscles. Cells developed in chyle of a subspherical form, greyish white colour, about $\frac{1}{2500}$ of an inch in diameter, often tuberculated on their surfaces. When found in the blood they are called *white corpuscles*.

Chylopoietic (Gr. χυλός, and ποιέω, *I make*). Organs concerned in the formation of chyle; hence the stomach, duodenum, and liver are termed *chylopoietic viscera*.

Chyme (Gr. χυμός, *juice*). The pulpy layer of digested matter which adheres to the inner surface of the intestine, and yields the chyle by admixture with the biliary secretion.

Chymistry. [CHEMISTRY.]

Ciborium (Lat.). In Architecture, an isolated erection, open on each side, with arches, and having a dome of an ogee form supported by four columns. It is placed on the altar of Roman Catholic churches, and contains the Host, or consecrated wafer.

Cibotium (Gr. κιβωτός, *a chest* or *coffer*). A genus of Ferns, one species of which is the Baranetz or Scythian Lamb, of which travellers have told strange tales. This plant is known as *C. Baranetz*, and its rhizomes may be cut so as to assume a quaint resemblance to some small animal. The silky hairs which envelope the crown of this, and probably some other allied plants, are collected under the name of Penghawar Djamba, and employed in medicinal practice as a styptic. A similar hair-like substance, known as Pulu, obtained in the Sandwich Isles from other species of the genus, is used for stuffing mattresses.

Cicada (Lat. *a grasshopper*). The name of a Linnæan genus of insects, celebrated in all ages for their powers of song or shrill chirp.

> Et cantu querulæ rumpent arbusta cicadæ,
> (*Georgics* iii.)

sings Virgil; which Dryden renders,

> When creaking *grasshoppers* on shrubs complain:

although it is evident that Virgil refers to the insects of the present genus, which habitually frequent shrubs and trees, and feed on their juices, having a peculiar apparatus for piercing the bark and sucking out the juice. They are therefore more accurately described by Lord Byron as

> The shrill Cicadæ, people of the pine.

The *manna* of the shops is the inspissated juice of the *Fraxinus Ornus*, poured out from the wounds inflicted by the *Cicada orni*. The organ of sound is peculiar to the male, and is situated on each side of the under and anterior part of the abdomen. The insects referable to the Linnæan genus *Cicadæ* are now separated into three families, *Cicadidæ*, *Fulgoridæ*, and *Cercopidæ*.

Cicatrix (Lat.). The scar which remains after the skinning over of a wound.

Cicer (Lat.). A leguminous genus related to *Ervum*, one of whose species, *C. arietinum*, is much grown as a pulse in India and other Eastern countries, under the names of Chick-pea and Gram.

Cicerone (Ital.). A name originally given by the Italians to those persons who pointed out to travellers the interesting objects with which Italy abounds; but applied universally at present to anyone who acts as *a guide*. This application of the term *cicerone* has probably its origin in the ironical exclamation, 'E un Cicerone' (he is a Cicero), referring to the well-known garrulity of the Italian guides.

Cichoraceæ (Cichorium, one of the genera). One of the three great divisions of *Compositæ*, a very extensive order of herbaceous or shrubby Exogens. The plants belonging to this division have a milky juice, and form a connecting link between *Compositæ* and *Campanulaceæ*. They inhabit the whole world, and are characterised by all the florets of the flower-heads being alike and ligulate. Lettuce, Succory, and Endive are familiar examples of *Cichoraceæ*, which are generally bitter, with a soporific quality resembling that of opium. The Cichoraceæ are synonymous with the *Liguliflora*.

Cichorium (Gr. κίχορα). The Chicory or Succory genus, from which that division of the Composites with all the florets in the head strap-shaped takes its name. It contains the Endive, *C. Endivia*, a favourite salad plant; and the Chicory, *C. Intybus*, which has coarsely-toothed pinnately lobed lower leaves, a tall stem with many blue flower-heads, and a long thickish fleshy root, which forms an article of cultivation, and has been largely employed for mixing with coffee. It possesses medicinal properties resembling those of the dandelion.

Cicindela (Lat. *a glow-worm*). A name applied by Linnæus to a genus of beetles, which is placed at the head of the order *Coleoptera* from the circumstance of the outer lobe of the maxillæ being converted into an additional pair of feelers, called internal maxillary palpi. The mandibles are very strong and armed with strong teeth; the maxillæ are terminated by a movable spur; the eyes are large and prominent; and the wings generally well-developed. Endowed with such powers of perception, locomotion, and destruction, it may readily be inferred that these insects are a cruel and predatory race. Like the carnivora of a higher class, they are remarkable for the beauty of their colours, and were termed by Linnæus the tigers of the insect world. The species referable to the Linnæan *Cicindela* are extremely numerous, and are divided into twenty subgenera, of which one only is British, and to this the term *Cicindela* is restricted.

Cicisbeo (Ital.). A word synonymous with *cavaliere servente*, and applied to a class of persons in Italy who attend on married ladies with all the respect and devotion of lovers. This practice is now on the decline. Though the office of a cicisbeo has been the subject of frequent invective, it has not been without its advocates and admirers. Among

others Baretti, in his *Account of the Manners, &c. of Italy*, vol. i. c. viii., ascribes it to a spirit of gallantry derived from the ages of chivalry, and much refined by the revival of the Platonic philosophy in Italy about the thirteenth century, and by the verses of Petrarch and his many imitators.

Ciconia (Lat. *a stork*). A genus of wading birds of the tribe *Cultrirostres* of Cuvier; including the white stork (*C. alba*), the black stork (*C. nigra*), and the American stork (*C. Magnari*).

Cicuta (Lat.). A poisonous genus of the *Umbelliferæ*, one species, *C. virosa*, found in wet places in this country, being known as the Water Hemlock. The fruit is roundish, crowned with the calyx teeth, each half marked with five scarcely prominent ridges, and having a single oil-channel under each furrow. It is a hollow-stemmed herb, with tripinnate or bipinnate leaves having long narrow leaflets. The large fleshy rootstock is also very poisonous.

Cid (Arab. seid, *lord*). The name given to an epic poem of the Spaniards which celebrates the exploits of their national hero, Roderigo Diaz, count of Bivar, whose name Campeador reappears in the English CHAMPION [which see]. It is supposed to have been written in the thirteenth century, about 150 years after the hero's death; but unfortunately the author's name has not been transmitted to posterity. (Southey's *Chronicle of the Cid.*)

Cider (Fr. cidre). A fermented liquor made from the juice of apples. Cider is made in all the temperate climates of the world which are not sufficiently warm for maturing the grape, and where the cold is not so great as to confine the inhabitants to the beer produced by a fermented decoction of grain. Cider is formed by grinding or crushing the apples when ripe, either in a circular stone trough by a stone roller turned by a horse (which is the common practice in Worcestershire, Herefordshire, &c.), or between fluted or spiky, and afterwards between smooth rollers of wood or iron, driven by men (as practised in Devonshire, and in most places where cider is made on a small scale). The apples, including the core and the seeds, having been reduced to a pulp by crushing or grinding, the mass is put into hair-cloths and powerfully pressed; and the liquor which runs from it is put into casks, where it is allowed to ferment, the casks being freely exposed to the air in the shade. The progress of the fermentation is then carefully watched, and as the sediment subsides, the liquor is racked off; on the proper time being chosen for doing this depends the excellence of the cider. The best cider, other circumstances being the same, is that in which the fermentation has gone on slowly, and where the vinous fermentation has not gone so far as to become acetous. The check to fermentation consists in racking off from one cask to another. Before winter the casks are removed to a cellar, and by the following spring the liquor is fit for use, or for bottling. The principal cider counties in England are Worcestershire, Herefordshire, and Devonshire. The Worcestershire and Herefordshire cider will keep from twenty to thirty years; while the best Devonshire cider will rarely keep more than five or six years.

Cilia (Lat. *eyelashes*). The hairs which grow from the margin of the eyelids. The term is also applied to microscopic filaments or plates which project from animal membranes and are endowed with quick vibratile motion. In most of the lower animals the respiratory function is effected by means of the vibratile cilia; many animalcules and the gemmules of the Acrites move by a similar mechanism; and it has recently been ascertained that vibratile cilia have a share in the performance of some important functions in the highest classes of the animal kingdom, where they have been detected on the membrane lining the female generative and respiratory passages, and the ventricles of the brain.

CILIA. In Botany, long hairs situated upon the margin of a vegetable body, as on the leaves of the *Sempervivum tectorum*.

Ciliary (Lat. cilium). The *ciliary ligament* of the eye is the circular portion that divides the choroid membrane from the iris, and which adheres to the sclerotic coat. The *ciliary processes* are the white folds at the margin of the *uvea* in the eye, which proceed from it to the crystalline lens.

Ciliated (Lat. cilium). In Botany, a term used in describing the surface of an organ, to denote the presence at the margin of fine hairs resembling the eyelash, as in the leaves of *Luzula pilosa*.

Ciliograde, Ciliograda (Lat. cilium, and gradior, *I proceed*). The name of a tribe of Acalephans or sea-nettles, comprehending those which swim by means of cilia.

Cimex (Lat. *a bug*). A Linnæan genus of Hemipterous insects, now subdivided into the following families: *Pentatomidæ, Coreidæ, Lygeidæ, Cypridæ, Cimicidæ, Reduviidæ, Acanthidæ, Hydrometridæ*. Each of these families includes several genera, and each genus comprises many species; in all, the mouth consists of one lengthened and jointed proboscis, including several fine sharp bristle-like processes, which are employed in wounding the vegetable or animal substances on the juices of which these insects feed. The bed-bug (*Cimex lectularius*) may be regarded as a type of this extensive tribe of insects.

Cimolite or **Cimolian Earth.** A variety of clay found in amorphous earthy masses, of a grey colour, in the island of Cimolos (now called Argentiera) in the Grecian Archipelago, by the people of which it is used as a substitute for fuller's earth, for cleaning cloths.

Cinchona (named after the countess of Chinchon). One of the most important genera in the whole range of the vegetable kingdom, in a sanitary point of view, for several of its species yield the invaluable drug quinine. Cinchona, as its name indicates, is the type of the *Cinchonaceæ*, and consists of evergreen trees

growing in the tropical valleys of the Andes. They have white or pinkish flowers in panicles, with salver-shaped corollas, an ovary crowned by a fleshy disc, a simple style, and a two-cleft stigma. The capsule contains winged seeds, and opens from below upwards. The more important species are *C. Calisaya*, *succirubra*, and *Condaminea*. The cultivation of *Cinchonas* for a supply of quinine, which has been commenced both in the East and West Indies, appears likely to become a decided success.

Cinchonaceæ (Cinchona, one of the genera). A natural order of shrubby or arborescent Exogens, almost exclusively inhabiting the tropics and the hotter parts of the world, and formerly known under the name of *Rubiaceæ*. They are in some respects allied to *Compositæ*, from which their distinct stamens, bilocular or plurilocular ovary, small embryo, interpetiolar stipules, and inflorescence distinguish them. They are divided from *Apocynaceæ* by the æstivation of the corolla, the presence of stipules, and the inferior ovary. They are also very nearly related to *Caprifoliaceæ*, being only separated from them by their interpetiolary stipules. Powerful febrifugal properties in their bark or emetic properties in their roots are the great features of this order, the most important medicinal products of which are Cinchona and Ipecacuanha. Many of the genera are fragrant, and some possess great beauty, as *Gardenia*, *Luculia*, *Ixora*, *Bouvardia*, *Rondeletia*, and others. Coffee also is produced by *Coffea arabica*, a plant belonging to this family.

Cinchonic Acid or **Kinic Acid.** An acid found in combination with the alkaloids in the varieties of Peruvian Bark, or *Cinchona*: it is crystallisable, and represented by the formula $C_{14}\,H_{11}\,O_{11}$, H O.

Cinchonidine. An alkaloid existing in small quantity in many cinchona barks, but abundantly in those of Maracaïbo and Bogota. It crystallises readily, and forms crystalline salts with acids.

Cinchonine. This alkaloid occurs with quinine in cinchona bark. It is separated from the latter by taking advantage of its smaller degree of solubility in alcohol, or of the greater solubility of its sulphate in water. It is volatile, crystallises in large prisms; and forms crystalline salts with acids.

Cincture (Lat. cinctura, *a girdle*). In Architecture, the ring, or fillet, at the top and bottom of a column, which divides the shaft from the capital, or from the base, is known by this name.

Cinder Bed. A part of the Middle Purbeck series entirely composed of oyster-shells. This is a very remarkable deposit, long known, and serving as a geological landmark. It is a marine bed lying among freshwater deposits, forming the termination of the great series of deposits of that middle secondary period to which so much of the physical geography of Western Europe and England is due. The cinder bed lies a little above the DIRT BED of Portland. Immediately below it is a series of freshwater strata with many fossil shells of species not found in the rocks above, and silicious beds of chert passing into beautiful chalcedony are amongst them.

The whole series of beds connected with this deposit is of unusual interest in Geology as pointing to the condition of neighbouring land. [OOLITIC SERIES and DIRT BED.]

Cinder Iron. The cinder from the refinery of iron, which often contains as much as 60 or 70 per cent. of iron, is sometimes mixed with the fresh ore at the melting furnaces; but the resulting material is of a very inferior character, and the pig iron so obtained is rough and uneven upon the surface, porous in its internal character, and very irregular in its powers of resistance. The refinery pig, which contains much cinder, is lighter in weight than ordinary metal, and the quality of the bars is always inferior to that obtained from the natural mine.

Cinematics. [KINEMATICS.]

Cingulum (Lat. *a girdle*). In Zoology, is technically applied to the neck of a tooth, or to that more or less distinct constriction which separates the crown from the fang. The term *cingula* is also given to the transverse series of bony pieces connected together by tegumentary flexile joints, as in the middle part of the armour of the armadillo.

Cinnabar. An Indian name given, according to Pliny, to a mixture of the blood of the dragon and elephant, and to other substances of similar colour. It is now exclusively applied to the red pigment called *vermilion*, and to the mineral of which the former is an artificial preparation. The ore from which the mercury of commerce is obtained is a protosulphide of mercury, composed, when pure, of 86·21 per cent. of mercury, and 13·79 of sulphur. The principal mines of this mineral are those of Idria in Carniola, and Almaden in Spain, but it is also abundant in China, at New Almaden in California, in Mexico, and in Tuscany.

Cinnamein. A fragrant compound contained in balsam of Peru.

Cinnamic Acid. When the essential oil of cinnamon is exposed to air, it gradually absorbs oxygen and deposits crystals of cinnamic acid $= C_{18}\,H_7\,O_3$, H O. It much resembles *benzoic acid*, into which it is converted when mixed with bichromate of potash and sulphuric acid. This acid is found, together with benzoic acid, in Peruvian and in Tolu balsam, from the latter of which it is readily obtained.

Cinnamon (Gr. κιννάμωμον, Heb. kinnâmôneh). The bark of the *Cinnamomum zeylanicum*, a lauraceous tree, native of Ceylon, whence the finest cinnamon is obtained; it is of an astringent and highly aromatic and warm flavour, and yields by distillation an extremely fragrant and pungent volatile oil, kept for pharmaceutical use under the name of *oil of cinnamon*. An inferior kind of cinnamon is often met with in commerce, which is remarkably deficient in flavour.

Cinnamon Stone. A variety of lime-Garnet, of a clear cinnamon-brown colour. It is very abundant in Ceylon, and is occasionally cut and polished for jewellery; in fact, most of the stones sold as Hyacinths are in reality Cinnamon Stones. It is a silicate of alumina and lime. In Scotland this stone is found at the limestone quarries at Glen Gairn in Aberdeenshire, and large crystals of a rich cinnamon colour are met with in a coarse crystalline Dolomite at Bun Beg, near Gweedore; at Kilranelagh, Wicklow, &c.

Cinnamyle. The supposed *radical* of oil of cinnamon, of which the oil is the *hydruret*. The formula of cinnamyle is $C_{18}H_7O_2$, and that of oil of cinnamon, $C_{18}H_7O_2+H$.

Cinque Ports or **Five Ports.** The seaport towns of Dover, Sandwich, Hastings, Hythe, and Romney; to which three others were afterwards added, viz. Winchilsea, Rye, and Seaford. These towns are incorporated, with peculiar privileges; are under the government of a lord warden, to whom writs for the return of members to parliament from them are directed; and the members so returned are termed Barons of the Cinque Ports.

Cinquecento (Ital. for *five hundred*, and an abbreviation for mille cinquecento or *fifteen hundred*). In Painting and Ornament, this term is applied to designate the art styles of the sixteenth century, or such as were developed about or after 1500. In like manner the terms *trecento* and *quattrocento* denote art of the fourteenth and fifteenth centuries. The Cinquecento is the period of the highest perfection of the arts of the Revival.

Cipher (Fr. chiffre, Ital. cifra, perhaps from Arab. cifr, *a dot*). The symbol 0 in numerical notation, which has no intrinsic value, but serves to determine the local value of the other digits by which it may be accompanied in the expression of any number. [ARITHMETIC.]

CIPHER is sometimes used in common language to signify any arithmetical character; hence the verb *to cipher*, which signifies to perform an arithmetical operation.

Cipolin. A green marble with white zones, somewhat like the section of an onion.

Cippus (Lat.). In Roman Antiquities, a name applied to sepulchral monuments which consisted of a small column whether round or rectangular.

Circinate (Lat. circino, *I make circular*). In Botany, a term used in describing the æstivation of flowers and the direction of plants in general, to denote those which are rolled spirally downwards, so that they are bent like the head of a crosier; as the shoots of young ferns, the inflorescence of Boraginaceous plants, the leaves of the Sundew, &c.

Circinus (Lat.). The Compasses: a constellation of four stars near the South Pole.

Circle (Lat. circulus, dim. of circus, *a ring*). According to Euclid, a circle is a plane figure contained by one line, which is called the circumference, and is such that all straight lines drawn from a certain point within the figure to the circumference are equal to one another. The point which possesses this property is called the centre of the circle. The straight line and the circle are the only figures admitted into plane or elementary geometry, all questions in that branch of mathematics depending on the intersections of straight lines with straight lines, of straight lines with circles, or of circles with circles. This distinction was established by the ancient geometricians, who regarded the other geometrical figures as formed by the intersections of planes with solids, and thence denominated problems for the solution of which the properties of other figures than the straight line and the circle were required, *solid problems*. In modern geometry, however, a circle is classed, with the conic sections, amongst quadrics or curves of the second order which have the property of cutting every line in two real or imaginary points. The principle of continuity leads us to regard the infinitely distant points of a plane as situated upon one and the same right line, and all circles as quadrics which pass through the same two fixed imaginary points on this line at infinity; these points are called the *circular points* at infinity. To explain this, it may be remarked, in the first place, that the equation $\frac{x}{a}+\frac{y}{b}=1$ of a line assumes the paradoxical form $1=0$ when the intercepts a, b, determined by the line on the coordinate axes, increase indefinitely; in other words, $k=0$, where k is a linear constant, must be regarded as the equation of the line at infinity. But by giving suitable values to A, B, C, the equation of any circle whatever may be written in the form

$$x^2+y^2-r^2+k\,(\mathrm{A}x+\mathrm{B}y+\mathrm{C})=0,$$

which clearly intersects the line at infinity ($k=0$) in the same imaginary points in which that line is intersected by the circle $\mathrm{S}=x^2+y^2-r^2=0$ around the origin. Hence two circles, like every other pair of quadrics, may be regarded as intersecting one another in four points, two of which always coincide with the imaginary circular points at infinity.

In a similar manner we may regard two concentric, and therefore non-intersecting circles, as having double contact with each other at the circular points at infinity. For in general, if $\mathrm{S}=0$ represent the equation of a quadric, and $\mathrm{L}=0$, $\mathrm{M}=0$ those of two right lines, $\mathrm{S}+\mathrm{LM}=0$ will be the equation of another quadric passing through the four intersection points of L and M with S, and if L and M coincide $\mathrm{S}+\mathrm{L}^2=0$ will represent a conic touching S in the two points in which L intersects S. If S represent a circle, and L the line $k=0$ at infinity; then $\mathrm{S}+k^2=0$ will be a circle having double contact, at the circular points, at infinity, with $\mathrm{S}=0$. But these equations clearly belong to concentric circles, since they only differ in their absolute terms.

The rectification of the circle, or the determination of the ratio of the circumference to the diameter, is a problem which has exercised the ingenuity of mathematicians in all ages.

It cannot be expressed in finite numbers; but numerous series have been invented from which it may be computed to any required degree of precision. Archimedes, in his treatise *De Dimensione Circuli*, proved that if the diameter is expressed by 7, the circumference is very nearly 22. A nearer ratio, which is generally used in ordinary measurements, is 113 to 355; and it has the advantage of being easily remembered, the numbers being formed of the three first odd numbers, each repeated. Vieta carried the approximation to 10 places of figures, and Van Ceulen to 36. Mr. Abraham Sharp computed the ratio to 72 places of figures; De Lagny, in the *Memoirs of the Academy of Sciences of Paris*, to 128; and lastly Dr. Clausen, in Schumacher's *Astronomische Nachrichten* (No. 589), to 250 places. Supposing the diameter 1, the first 36 figures by which the circumference is expressed (the ratio found by Van Ceulen) are 3·14159,26535,89793,23846,26433,83279,50288

The ratio of the circumference to the diameter of a circle is invariably denoted by the Greek symbol π. The area of a circle may be easily shown to be equal to that of a triangle whose base is the circumference and whose altitude is the radius. It is therefore expressed by πr^2 and, like π itself, can only be determined approximately; hence the impossibility of *squaring* the circle. Since the invention of the infinitesimal calculus, the discovery of convergent series for the rectification and quadrature of the circle is a matter of comparative facility. A number of such may be seen in all works on Trigonometry, and especially in Euler's *Introductio in Analysin Infinitorum*.

Circle of Contact or **Osculating Circle.** The circle which *fits* closest to any given curve at a given point. A circle being determined by three points, we can only demand from it that it shall have three consecutive points in common with the curve; the contact, therefore, will in general be *three-pointic*, or of the *second order*. In general, the circle of contact will cut the curve. [CONTACT; OSCULATION.]

Circle of Curvature. The circle whose curvature, or amount of bending, is the same as that of a given curve at any given point. [CURVATURE.] It is the same as the *circle of contact* or *osculating circle*.

Circle at Infinity, Imaginary. The imaginary circle in which the plane at infinity is intersected by every sphere. If $S=0$ represent the equation of any given sphere, that of any other sphere may obviously be written in the form $S+kL=0$, where k is a linear constant, and $L=0$ is the equation of a plane. These two spheres clearly intersect in two circles one of which lies in the plane $L=0$, the other being the intersection of $S=0$ with the plane $k=0$ at infinity. The latter circle, consequently, is common to every sphere.

Circle, Six-points. The circle which passes through the middle points of the sides of a triangle. It passes also through the feet of the three perpendiculars let fall from the angles upon the opposite sides, and possesses many very remarkable properties. The same circle is referred to by Continental writers as the *nine-points circle*, since, besides the six points already named, the middle points of the three lines joining the corners of the triangle to the intersection of the three perpendiculars also lie in its circumference. Feuerbach, Brianchon, Poncelet, Steiner, and many others, have investigated the properties of this circle. The first of these geometers, in his *Eigenschaften des Geradlinigten Dreyecks*, &c. (Nürnberg, 1822), discovered that it touched the inscribed, as well as the three exscribed circles of the triangle, a property which was afterwards generalised by Sir W. Hamilton, Dr. Hart, and others. (*Quart. Journ. of Math.* vol. iv. p. 245.)

Circuits (Lat. circuitus, *a going round*). In England, Scotland, and Ireland, divisions of the kingdom appointed for the judges of assize; two of whom go each circuit twice a year, to deliver the gaols and try issues at nisi prius. England is divided into six circuits—Home, Midland, Oxford, Norfolk, Western, Northern; Wales into the North and South Welsh circuits. A single judge travels each of the Welsh circuits, and these two meet at Chester to transact the business of that county. The judges choose their own circuits; the three chiefs, and the puisne judges, in order of seniority, making their election. The circuits are after Hilary and Trinity Terms, and vary in their duration from three to seven or eight weeks; but a third or winter circuit is usual in some of these divisions. [COURTS, SUPERIOR AND ASSIZE.] The circuit or assize towns in most counties have been fixed by immemorial usage, but some changes have been made by the authority of the Privy Council. Barristers at the common-law bar choose their circuits on first embarking in their profession, and etiquette allows of only one subsequent change. The insolvent commissioners also make circuits thrice a year through the kingdom for the discharge of debtors.

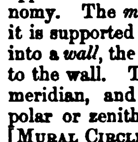
Circular Cubic. A cubic or curve of the third order which passes through the circular points at infinity. It bears the same relation to a general cubic that a circle does to a quadric. [CIRCLE.] The general form of the equation of a circular cubic is $(x^2+y^2)L=kS$, where $S=0$ denotes a quadric, L a linear function of the coordinates, and k a linear constant. (Salmon's *Higher Plane Curves.*)

Circular Functions. This term, as generally employed, is synonymous with trigonometrical functions.

Circular Instruments. The name given to any astronomical or nautical instrument for measuring angles, in which the graduation extends round the whole circumference, or to 360°. Formerly it was thought sufficient to carry the divisions over a portion of a circle only, whence the quadrants, sextants, and octants, once so common; but experience has shown that entire circles (especially where the instruments are of considerable size) have a great advantage over graduated segments; and

hence, excepting the sea-sextant, the latter are now seldom used. The principal circular instruments used in astronomy are *altitude and azimuth circles*, *mural circles*, *reflecting circles*, and *repeating circles*. The altitude and azimuth circle, as its name implies, is used for measuring the altitudes and azimuths of stars; it is consequently composed of two graduated circles, one vertical and the other horizontal. This is a sort of universal instrument, being applicable to almost all the purposes of astronomy. The *mural circle* is so called because it is supported by means of a long axis passing into a *wall*, the plane of the circle being parallel to the wall. The instrument is placed in the meridian, and is used for determining the polar or zenith distances of celestial objects. [MURAL CIRCLE.] The *reflecting circle* carries a mirror, by means of which an object is seen by reflected vision; another object is viewed directly; the two are brought to coincide, and the angular distance between them is measured by the inclination of the mirror to the axis of the telescope. [SEXTANT.] The *repeating circle* or *multiplying circle* is so contrived that the observer is enabled to repeat or multiply the observation, by reading it off successively on different parts of the graduated limb. A number of values being thus found, the mean of the whole is taken as the correct result. This instrument is sometimes called *Borda's circle*, from the name of its improver. [REPEATING CIRCLE.]

Circular Parts. In Spherical Trigonometry, the name given to two rules, invented by Lord Napier and demonstrated in his *Mirifici Logarithmorum Canonis* (see also Todhunter's *Spherical Trigonometry*), for obtaining the formulæ relative to a right-angled spherical triangle. In any right-angled spherical triangle, let a and b denote the sides, c the hypothenuse, and A and B the angles opposite to a and b respectively. Take the two sides, and the complements of the hypothenuse and of the two angles, and write them in order round a circle, as in the annexed diagram; then, if any one part be called the *middle* part, the two next to it the *adjacent* parts, and the other two the *opposite* parts, the two following rules will hold good:—



1. The sine of the *middle* part is equal to the product of the tangents of the *adjacent* parts. 2. The sine of the middle part is equal to the product of the cosines of the *opposite* parts. Thus—

$\operatorname{Sin} a = \tan b \tan (90 - \text{B}) = \tan b \cot \text{B}$.

$\operatorname{Sin} a = \cos (90° - \text{A}) \cos (90° - c) = \sin \text{A} \sin c$.

Circular Points at Infinity. The two imaginary points in which any circle intersects the infinitely distant right line in its plane. [CIRCLE and LINE.]

Circulating or Recurring Decimal. A decimal in which certain digits are continually repeated. Thus ·15723723 . . . *ad inf.* is a circulating decimal, of which the figures 723 constitute the recurring *period*. For brevity, such a decimal is written thus $\cdot 15\dot{7}2\dot{3}$, the points over the 7 and 3 indicating the period. A recurring, or else a finite, decimal is always obtained when attempting to convert a common fraction to a decimal; and conversely, every recurring decimal can be expressed as a fraction, the numerator of which is the difference of the numbers formed, respectively, by taking all the digits up to the first and up to the second periods, and whose denominator consists of as many digits 9 as there are digits in the period, followed by as many ciphers as there are digits in the non-recurring part of the decimal. Thus, in the above example, the equivalent fraction is $\frac{15723 - 15}{99900} = \frac{15708}{99900}$.

Circulation of the Blood. The passage of the blood through the various tissues of the body. In warm-blooded animals, the heart is divided into four cavities: two auricles and two ventricles. The circulating venous blood enters into the right auricle by and from the two *venæ cavæ*, inferior and superior. Thence it passes into the right ventricle, whence the blood, still venous, is forced by the pulmonary artery into the lungs. The contact of the oxygen contained therein, admitted through the trachea and ramified through the bronchial tubes over the whole extent of the lungs, changes the blood from venous to arterial. This scarlet blood is returned from the lungs by the pulmonary veins, entering the left auricle, and subsequently the left ventricle. Thence it is driven through the *aorta* into the arteries, and distributed by the capillaries to the various tissues. The veins then once more collect the blood, and return it by the *venæ cavæ* to the heart. In reptiles there is but one ventricle, and the mixed blood contained therein is transmitted partly into the lungs, and partly into the body. In Crocodilia a partial partition divides the ventricle. In fishes only two cavities exist: an auricle and a ventricle; and consequently only venous blood is received and transmitted. [BLOOD.]

Circumcelliones (Lat. from circum, and cella, *a house*). In Ecclesiastical History, an African sect of the fourth century, so called from their habit of begging from door to door. They asserted the civil equality of all men, and, carrying to an extreme the tenets of the Donatists, were specially conspicuous in their eagerness for martyrdom, which, in default of persecutors, they often inflicted on each other (Milman's *History of Christianity*, book iii. ch. i.)

Circumcision (Lat. circumcisio). The initiatory rite of the Jewish covenant. This custom has long been prevalent among Eastern nations. Herodotus refers to it as the practice of the Egyptians and Ethiopians, and as borrowed from them by the Phœnicians and Syrians. It is enforced by the Koran upon all the disciples of Mohammed, whether from an idea of cleanliness, or merely as a distinguishing rite.

Circumference. The curved line which encloses a plane space. The broken line which encloses a rectilinear figure is usually distinguished as the *periphery*. The latter term is derived from the Greek words περί and φέρω; the former from the synonymous Latin words *circum* and *fero*.

Circumferentor. An instrument used by surveyors for taking angles. It consists of a graduated brass circle, and an index all of one piece, and carrying a magnetic needle suspended above the centre of the circle. The index being directed to an object, the angle which it makes with the magnetic meridian is noted. The index is then directed to the second object, and the angle it makes with the same meridian observed in like manner. The difference (or sum, as the case may be) of the two observed angles gives the angle between the two objects. It is evident that only a very rough approximation can be obtained in this manner. For the purposes of surveying, a pocket sextant is a far preferable instrument.

Circumflexus (Lat.). A muscle of the palate: the term is also applied to arteries which wind round bones or joints.

Circumpolar Stars. Stars which, at any given place, move round the pole, or complete their diurnal circles, without setting. The number of stars so circumstanced increases with the latitude of the place or the elevation of the pole above the horizon.

Circumscissile (Lat. circumscindo, *I cut round*). A mode of dehiscence observed in the fruit of some plants; it occurs by a transverse circular separation of the sides of the ovary, as in *Anagallis* and *Hyoscyamus*.

Circumscribed Figures. [Inscribed and Circumscribed Figures.]

Circumscription (Lat. circumscriptio). In Botany, the line representing the two edges of a leaf, or other organ, i.e. its margin.

Circumvallation (Lat. circum, *about*, and vallum, *a rampart*). In Fortification, an intrenchment thrown up by an investing army, facing outwards from the place invested, to resist attacks from the field, is called a 'line of circumvallation.'

Circus (Lat.). A long, straight, and narrow building, whose length is to its breadth as five to one. It was divided down the middle in the examples which have survived by an ornamental barrier called the *spina*, and this class of building was used by the Romans for the exhibition of public spectacles and of chariot races. There were several of these structures at Rome, of which the most celebrated was the Circus Maximus, which was altered and improved by Julius Cæsar, and was by him supplied with water to allow of its serving occasionally as a naumachia. Augustus added to it the celebrated obelisk now standing in the Piazza del Popolo; but no vestiges of the circus itself remain. Besides this one, there were at Rome the circi of Flaminius, near the Pantheon; the Agonalis, occupying the site of what is now the Piazza Novana; that of Nero, on a portion of which St. Peter's now stands; those of Florus Antoninus and Aurelian, no longer even in ruins; and that of Caracalla, which was 738 feet in length, and is still sufficiently perfect at the present day to exhibit its plan and distribution in the most satisfactory manner. Some remains of circi are also visible at Bovillæ, Orange, and at Tarragona, and portions of a circus maritimus exist at Anagnia.

The spectacles exhibited in the circus were called the Circensian Games, and they consisted chiefly of chariot and horse races. The Romans, and the Greeks of the lower empire, were passionately fond of them, and particularly so of the chariot races, which often excited so much interest in the time of the emperors as to divide the whole of the inhabitants of the cities into factions, known by the name of the colours worn by the different charioteers. The disputes of these factions sometimes led to serious disturbances, and even occasionally to bloodshed.

Cirripeds, Cirripedia (Lat. cirrus, and pes, *a foot*; *curly-footed*). A class of fixed homogangliate animals, characterised by having a number of long curled articulated setigerous processes, analogous to the feet of the Crustaceans, which project from the central aperture of the multivalve shell protecting the body. These animals are commonly called Barnacles and Acorn-shells. [Lepadites and Balanites; Barnacle Geese.]

The following classification has been generally adopted:—

Order 1. Thoracica. Sub-order: Balanidæ (Acorn-shells).
Families: Balaninæ, Cthamalinæ.
Sub-order: Verrucidæ.
Sub-order: Lapadidæ (Barnacles).
Order 2. Abdominalia.
Order 3. Apoda.

Cirrostratus (Lat. cirrus, and stratus, *a bed* or *covering*). The *wane cloud*, intermediate between the Cirrus and Stratus. The *mackereled sky* of a summer evening, which is regarded as foreboding rain, is a modification of this cloud. [Cloud.]

Cirrous (Lat. cirrus, *a lock of curled hair*). In Botany, a term used in describing the apices of bodies, to indicate those that are terminated by a spiral or flexuose filiform appendage (cirrus), arising from an elongation of the costa, as in the leaf of *Gloriosa superba*. It is also applied to modifications of the branch, the inflorescence, the petiole &c. when such parts assume the state of a twisting body, which enables the plant belonging to it to raise itself upon neighbouring objects.

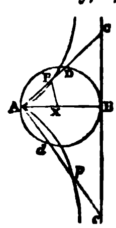
Cirrus (Lat.). The curl-cloud or mare's-tail.

Cirsocele (Gr. κιρσός, *a dilated vein*, and κήλη, *a tumour*). A morbid enlargement of the spermatic veins in the groin.

Cissoid of Diocles (Gr. κισσοειδής, *like ivy*). A curve invented by the Alexandrian mathematician Diocles with a view to the solution of the famous problem of the *duplication*

of the cube, or the insertion of two mean proportionals between two given straight lines. The curve is described as follows:—

From A, one of the extremities of the diameter of a circle, draw a straight line, A C (or A c), to meet the tangent through the other extremity, B, and make C P (or cp) equal to the intercepted chord A D (or A d); the points P (and p) will trace the cissoid.



Taking A as origin of rectangular coordinates, and A B as abscissa axis, the equation of the curve is easily found to be $x^3=(a-x)y^2$, a being the diameter of the generating circle. The cissoid, therefore, is a cubic curve of the third class, having a cusp at the origin, and a point of inflexion at infinity, at which the tangent is the asymptote c C. It also passes through the circular points at infinity, so that of its three foci two coincide. It may, moreover, be regarded as the pedal of a parabola with respect to the vertex; in other words, it is the locus of the vertex of a parabola which rolls upon an equal parabola, so that corresponding points of the curves always coincide with their point of contact; it is also the inverse of a parabola with respect to its vertex. Another remarkable property of the cissoid is, that the whole space lying between the double branches and the asymptote is equal to triple the area of the generating circle. A method of describing the cissoid mechanically by the motion of a rectangular rule, is given in Newton's *Universal Arithmetic.*

Cist (Lat. cista; Gr. κιστή). In Architecture and Sculpture, a chest or basket. It is a term usually applied to the mystic baskets employed in processions connected with the Eleusinian mysteries. They were originally of wickerwork, and when afterwards made of metal the form and texture were preserved in imitation of the original material. When sculptured on antique monuments, it indicates some connection with the mysteries of Demeter (Ceres) and Dionysus (Bacchus).

Cistaceæ (Cistus, one of the genera). A natural order of shrubby or herbaceous Exogens inhabiting chiefly the countries of the South of Europe and North America. They are distinguished from *Violaceæ* by their indefinite stamens and inverted embryo; from *Bixaceæ* by the last character, by their mealy albumen, their habit, and by never having their leaves dotted; from *Hypericaceæ* by the latter character, and the structure of the fruit. They are allied to *Papaveraceæ* by the genus *Dendromecon*; but their true station appears to be in the vicinity of *Linaceæ*, to which they approach by the genus *Lechea*. They are often plants of great beauty, but possess no sensible properties, excepting the *Cistus creticus* and a few others, which yield the resinous balsamic substance called *gum labdanum.*

Cistercians. In Ecclesiastical History, a monastic order deriving their name from the abbey of Citeaux, which was founded by Stephen Harding (an Englishman, who had been a monk at Molesme in Burgundy) at the close of the eleventh century. In discipline, this order was a reform of the Benedictine rule; and amongst its earliest and most celebrated members was St. Bernard.

Citadel (Ital. citadella, dim. of citta, *a city*). A strong fort, constructed within fortifications, and intended as a last place of defence for a garrison.

Citation (Lat. citatio, from cito, *I summon*). In Ecclesiastical Law, an act whereby the defendant, on the application of the plaintiff, is commanded to appear in court on a certain day in order to enter into a suit. In the Civil Law, reference to an authority or precedent in the course of a pleading is termed a *citation*; and hence the common use of the word in the same sense with *quotation*, *allegation of instances*, &c.

Citraconic Acid. One of the products of the action of heat upon citric acid.

Citramide. The product of the action of ammonia on citric ether.

Citribic Acid, Citricic Acid, Citridic Acid. Acids derived from the *Citric acid*, and identical or isomeric with the *Citraconic*, *Itaconic*, and *Aconitic* acids.

Citric Acid (Lat. citrus, *the lemon*). The pure acid part of lemon and lime juice; it is also found in other fruits. Crystallised citric acid is largely prepared for domestic use.

Citridic Acid. [Aconitic Acid.]

Citrine Ointment. An ointment containing nitrate of mercury; it has a lemon-yellow colour. The *unguentum hydrargyri nitratis* of the Pharmacopœia.

Citronyl. *Citrene.* A hydrocarbon composing the greater portion of oil of lemons.

Citrullus. The well-known cathartic drug called *colocynth* is furnished by a species of this genus, *C. Colocynthis.* The genus is known by its unisexual flowers, and the persistent five-parted calyx and corolla, the male flowers with five stamens united in three bundles, and the females with a three to six-celled ovary, a cylindrical three-cleft style, and kidney-shaped stigmas. The drug obtained from Spain, the Levant, &c. consists of the round fruits or gourds, the pulp of which is light and spongy and intensely bitter.

Citrus (Lat.; Gr. κίτρον). The genus of the Orange, Lemon, Citron, Lime, Shaddock, and various other well-known fruits. It belongs to the *Aurantiaceæ*, and is known by its cup-like calyx, its numerous stamens irregularly united by their filaments into several bundles, and its pulpy fruit with a spongy rind. The leaves are remarkable as being compound, yet having but one leaflet, jointed on to the leaf-like stalk. The Citron, *C. Medica*, furnishes some essential oils; the Lemon, *C. Limonum*, is used in medicine and for various domestic purposes; and the Orange, *C. Aurantium*, and the Shaddock, *C. decumana*, yield dessert fruits.

City (Fr. cité, Ital. città, Lat. civitas). A borough or town corporate, which is or has

been the seat of a bishop, or the capital of his see; and it differs in no respect but that of superior dignity from any other borough. Some cities and a few boroughs are counties in themselves.

Civet. A brown semifluid matter contained in a gland near the anus of the *Viverra Civetta* or *civet cat*: its odour is offensive unless extremely diluted, and then in combination with other perfumes it adds to their energy. The term *civet* is Arabic. When genuine, this matter is worth from 25*s.* to 35*s.* per oz.

Civil List. The term formerly applied to the list of all the expenses of the government, or 'of all the heads of public expenditure, excepting those of the army, the navy, and the other military departments;' but confined at present by the Act 1 Wm. IV. c. 25 to expenses proper for the maintenance of his majesty's household. In England the civil list is fixed in the first session of parliament after the accession of the sovereign, and is then understood to be granted for the whole period of his reign.

Civilian. One learned in the Civil or Roman Law; particularly a member of the 'College of Doctors of Law exercent in the Ecclesiastical and Admiralty Courts' in England and Wales, in which courts the civil law is recognised. [Law, Civil.] Practice as an advocate in those courts was confined to members of this college, who must have taken the degree of Doctor of Law in the university of Oxford or Cambridge; but a change was effected by the establishment of the Probate and Divorce Court, which was thrown open to barristers in general, in 1857.

Clairvoyance (Fr. *clear-sightedness*). This term is generally applied to that faculty which is claimed for certain persons under what are called mesmeric or magnetic conditions. This faculty amounts to a transference of the senses, enabling the possessor to read with his fingers or stomach, to see absent objects, to know things of which he has never heard, with other pretensions of even greater extravagance. The phenomena of clairvoyance have been minutely examined in the eighth edition of the *Encyclopædia Britannica* under the head of 'Somnambulism;' and the general result of the tests applied is to show that there is no magnetic influence or nervous fluid, which passes from the operator to the person operated on, and that all the recorded phenomena which rest on any trustworthy evidence can be accounted for on ordinary principles. It must, of course, be admitted that mere trickery and collusion on the part of its professors afford no sound reason for declaring that the pretended science of mesmerism has no real foundation whatever; but 'if it appears that in no case whatever, where clairvoyance is subjected to scientific scrutiny, it is able to establish its pretensions, we shall be justified in coming to the conclusion that it is nothing more than a gigantic swindle, and that its professors are no more than arrant impostors.' The spirit-rapping mania, which has invaded this country from the United States, is only another form of the same delusion.

Clamp. In Brickmaking, a large mass of bricks, generally quadrangular in plan, and six, seven, or eight feet high, arranged in the field for burning, which is effected by flues prepared in stacking the clamp, and by lighting the breeze and cinders laid between each layer or course of bricks. Clamp-burnt bricks are very irregular in their quality; but there is a notable economy in the quantity of fuel required to prepare the same number of bricks as compared with kiln-burning.

Clamp. In Joiner's work, a piece of wood fixed to another with a mortise and tenon, or a groove and tongue, so that the fibres of the piece thus fixed cross those of the subjacent piece, and thereby prevent it from *warping* or *casting*.

Clan (Gael. clann, *children* or *descendants*). The clans of the Scottish Highlands are tribes consisting of many families all bearing the same surname, which according to tradition descend from a common ancestor. But it is more probable that most clans were formed of an aggregate of different families, the inferior standing to the superior in the same sort of relation as the Roman clients to their patrons, and by degrees assuming the same name. Some clans, however, are divided into branches, each possessing a distinct surname. The chieftainship of every clan descends regularly through heirs male; but in the earliest times of their history the rights of primogeniture were not very distinctly defined. The Gaelic clans occupy the northern and western with part of the central shires of the country.

Claret (from Lat. clarere, *to be clear*). A name applied to several of the Bordeaux wines. [Wine.]

Clarinet (Ital. dim. of clarino). A wooden musical wind instrument, whose mouth partakes of the trumpet form, and which is played by holes and keys: said to have been invented about the year 1600 by John Christopher Denner of Leipsic. Like the oboe, it is played with a reed mouthpiece, though it is of somewhat different form. For its compass, see table at the end of Music.

Classes (Lat.). In Ancient History, this term is particularly applied to the division of the Roman people said to have been made by Servius Tullius for the purpose of distributing them into centuries. [Centuries.]

Classic. In Antiquity, the Roman people were divided into classes, and the highest order were by preeminence termed *classici*. Hence the name came to signify the highest and purest class of writers in any language; although, down to a comparatively recent period, the term was used merely to denote the most esteemed Greek and Latin authors. Nothing marks more strongly the increased attention to, and appreciation of, modern literature, than the now universal application of the term to modern languages also, and the establishment

in this manner of a line between those authors whom we regard as models and authorities in point of style, and those who are not so highly esteemed. The epithet *classical*, as applied to ancient authors, is determined less by the purity of their style than by the period at which they wrote. Thus we speak of the classical age of Greek or Latin writing. With respect to the former, the classical age begins with Homer, the earliest Greek writer with whom we are acquainted. The purest age of Greek classical literature may be said to end about the time of the Macedonian conquest, or about 300 B.C.; but, in a wider sense, it extends to the time of the Antonines, and embraces a much larger catalogue of authors; while the centuries subsequent to that time produced a few who by the purity of their style deserve to be ranked with earlier classics. The Latin classical period is shorter; its earliest writer is Plautus, and the language may be said to have lost its classical character about the same time with the Greek, i.e. the reigns of the Antonines; although this limit is arbitrary, and some later writers (even down to Claudian) are generally included among classics. Within the Latin classical era there is a more restricted period of the purest Latinity, comprising the age of Cicero and that of Augustus.

CLASSIC. In the Fine Arts, a term denoting that the principle of the arrangement of a subject is such as would have suggested itself to the minds of architects or artists of the early and the more decidedly classical period, in which the accessories or the parts of a design are suitable to its general character, and such that nothing can be introduced which does not strictly belong to the particular class under which it is placed.

Classification. In Æsthetics, an arrangement by which objects of the fine arts are divided into classes; as, for instance, in galleries of paintings the works should be arranged in schools, each school being subject to a chronological order of the masters. In Numismatology, the coins should be arranged by countries, and these again by the chronological order of the monarchs; and so with other branches of the arts.

Classification in Geology. The principles of classification in this science involve a reference to the circumstances under which rocks were originally formed, the nature of their accidental contents, and the changes they have undergone since they were formed. To identify rocks, we must do more than identify mineral condition, or even make out a few fossils; and to classify them properly, much minute knowledge of Palæontology is requisite.

The necessity of classification in Geology is evident, and its value in practice is considerable. Certain rocks in all countries serve as landmarks, some leading to the discovery of valuable minerals, others valuable in themselves; and to be able in a foreign country to identify by any means a rock whose position in the general series is well ascertained, is to save a great amount of labour.

The principles of classification now universally adopted have reference to the inhabitants of the earth and sea at the time of each deposit, for it is found not only that each part of the earth has its own fauna and flora, but that each period of its history, marked by a group of deposits, is characterised in a similar manner. It is not indeed the case, as was once supposed, that particular species, whether of plants or animals, are sufficient to identify a rock. Careful study of the known groups and the comparison of collections, not merely of individual specimens, is usually required in doubtful cases; but the subject is reduced within a definite limit, and so much advance has already been made towards identification in distant parts of the world, that gaps will soon be filled up. [PALÆONTOLOGY.]

To the examination and comparison of fossils must be joined a knowledge of the mineral nature of each deposit. Limestones will nowhere be found to contain groups of shells *in situ* similar to those found in the clay of the same time and place. Animals delighting in sand will not multiply and become characteristic in mud. Remains of tribes inhabiting by preference deep water will not be mixed up with those from shallow water, provided of course the remains are found where the animal lived. But many fragments of dead animals must be drifted, and thus admixtures take place and apparent confusion follows, requiring the exercise of great discrimination and experience on the part of the palæontologist. Practically, a naturalist of higher order must avail himself of the labours of the naturalist who devotes his time to species, as it is necessary that he should be able to generalise before he can determine what is the true meaning of the *facies* of a collection obtained from a clearly defined group of deposits.

Although the labour thus involved is great, the results are satisfactory, and an approach to a successive history of animated nature during all the changing events of the earth's transitions may ultimately be obtained. It is in fact now beginning to be made out. But it must not be supposed that such history can be perfect before the principles of classification are settled. They are still under discussion, and the result of enquiries and investigations up to the present time will be found in the article DESCRIPTIVE GEOLOGY.

After all enquiry is completed with regard to those rocks that generally or occasionally contain fossils, there must yet remain a large outlying group of crystalline and metamorphic rocks of all ages, very difficult to interpolate. Locally this can often be effected by actual observation, and thus many basalts and granites, schists and quartz rocks are placed satisfactorily enough. But a minute study of their condition and the circumstances of their history has led to little result hitherto so far as concerns the identifying distant mineral accumulations of the same

nature not containing fossils. There are some basalts or outpourings of lava whose age is well known from their eruption having taken place between certain marked geological epochs, and some granites and crystalline schists similarly identified; but they differ little from others, more modern and more ancient, and no conclusion can be arrived at where fossiliferous rocks are not at hand.

Fossils therefore, and the science they involve, PALÆONTOLOGY, must be regarded as the key to geological classification, and must be referred to accordingly.

CLASSIFICATION. In Natural History, denotes the arrangement or assortment of various objects into those several classes denoted by appellatives which are called *genera* and *species*. For classification in Botany, Zoology, Medicine, Chemistry, &c., see the separate articles.

Clausa (Lat. clausus, *shut*). A name given by Cuvier to a family of Acephalous bivalves, comprehending those which have the mantle open at one end, or near the middle, for the passage of the foot, and prolonged at the opposite end into a double tube for respiration and excretion.

Clausilia (Lat. clausus). A genus of land-snails, so named because the aperture of the shell is closed internally by a spiral lid. Many species of this genus are natives of Great Britain. The rugose or dark close-shell (*Clausilia rugosa*, Drap.) is not uncommon at Charlton, where it may be found under stones. *Clausilia biplicata*, Leach, is found at Battersea.

Clausthalite. A rare mineral generally resembling granular Galena. It is a selenide of lead in which part of the lead is frequently replaced by silver. It occurs in veins of Hæmatite at Clausthal (whence the name Clausthalite) and other localities in the Harz, near Freiberg in Saxony, and at the Rio Tinto mines in Spain.

Clavate (Lat. clava, *a club*). In Botany, club-shaped; as when a body is linear at the base, but towards the apex grows gradually broader.

Clavicle (Lat. clavicula, dim. of clavis, *a key*). The bone situated between the sternum or breast-bone and the acromion process of the scapula or blade-bone.

Clavus (Lat. *a nail*). The disease produced in grains of rye when they are changed to a brown or blackish colour by the action of a parasitical fungus called *Oidium abortifaciens*. These diseased seeds, called Ergot of Rye, or Spurred Rye, are a valuable agent in exciting uterine action during labour. A similar change occurs in other grasses; and, indeed, it is believed that the presence, often unobserved in pastures, of ergoted grasses is a fruitful source of mischief to cows in calf.

CLAVUS. A severe pain in the forehead, compared to the driving of a nail into the skull, has been called *clavus* by medical writers.

Claw or **Unguis.** In Botany, the narrow part at the base of a petal which takes the place of the footstalk of a leaf, of which it is a modification.

Clay (A.-Sax. clæg). A term applied to a variety of natural earthy compounds, all of which are essentially characterised by *plasticity*. Chemically speaking, they are hydrated silicates of alumina, often largely mixed with other substances; but their important uses in agriculture and the arts are referred to the above silicates. Several minerals are definite crystalline silicates, which by disintegration or decomposition contribute to the formation of clay: common felspar is a silicate of alumina and potash; Al_2, O_3; $3\ SiO_3 + KO, SiO_3$: it is one of the constituents of *granite*, and some of its varieties crumble, when exposed to the joint action of air and water, into a white clay: *Cornish clay* and the *Kaolin* of China are clays so formed, and may be represented as Al_2, O_3; $3\ SiO_3 + 2\ HO$. Other clays are less pure, from the admixture of sand, oxide of iron, or carbonate of lime, substances which importantly modify their properties. The varieties of *marl* are calcareous clays; and the *coloured clays* generally derive their various tints from the oxides of iron. The presence of these and some other extraneous matters renders some clays very fusible: the pure aluminous silicates are nearly infusible, but when lime, magnesia, or oxide of iron, is present, they become more or less fusible or vitrifiable, in proportion to the quantity of these bases present in the clay. The varieties of *fire-clay* used for lining furnaces, and other similar purposes, are nearly pure silicates, $= Al_2O_3, 3\ SiO_3$, with mere traces of alkaline bases and oxide of iron. The different red and yellow *ochres*, and *boles*, are mixtures of clay and hydrated peroxide of iron; some of them contain oxide of manganese. *Fuller's earth*, used for the capillary absorption of greasy matters, is also a porous silicate of alumina. Clay has some remarkable distinctive properties: it exhales a peculiar odour when wetted or breathed upon, and when dry and applied to the tongue, it adheres to it, in consequence of the rapidity with which it absorbs moisture: it readily absorbs ammonia, and many other gases and vapours generated in fertile and manured soils; hence its agricultural value. The important quality of *plasticity*, upon which the manufacture of porcelain and pottery depends, belongs exclusively to aluminous combinations in their humid state, so that they admit of being turned in the lathe or upon the potter's wheel, or of being moulded into the infinite variety of useful and ornamental products of the ceramic art. These forms are rendered permanent by careful drying, and subsequent exposure to high temperatures.

CLAY. In Agriculture, one of the most common ingredients that enter into the composition of soils. Indeed, it may be asserted that no soil whatever will maintain its fertility for any length of time without a due proportion of clay in its composition. The most fertile soils in the world are the alluvial deposits on the

banks of rivers; and these, in an agricultural sense, all belong to clayey soil. In many cases the clays of agriculture are intimately united with calcareous earths, and in others with sand; but in both cases these earths are in a state of such minute division, that the mixture has all the appearance and the mechanical properties of a strong clay, and they are treated by cultivators accordingly. Among the most tenacious clays of Britain are those of Middlesex; and these, when examined, are found in many cases to contain a considerable proportion of lime, and in others of sand. The best wheats are everywhere, both in Britain and on the Continent, grown on calcareous clays; and also the best fruits and flowers of the Rosaceous kind, such as apples, pears, plums, cherries, roses, &c.; but it is remarkable that the grape, when grown on clayey soil, produces neither high-flavoured fruit nor good wine.

Clay Ironstone. The name commonly given to the compact kinds of Siderite or carbonate of iron, which are rendered impure by an admixture of clay. These occur chiefly as flattened spheroidal masses of various sizes, in many clay formations, more especially amongst those of the coal measures, and furnish the greater part of the iron which is produced in this country. The colour of this ore is generally yellowish-brown or reddish-grey, the fracture is finely granular, it is easily scratched, and gives out an argillaceous odour when breathed on. [BLACK BAND.]

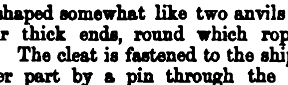
Clay-slate. [SLATE.]

Clayey Soil. Soil in which clay is the principal earthy ingredient. Soils of this description when first subjected to cultivation are expensive to work and uncertain in their produce; but after they have been drained, cultivated, limed, and manured, they become the most fertile of all soils, producing immense crops of wheat, beans, clover, rye-grass, &c. Great improvement is also effected in them by partially burning them.

Claylte. A variety of Galena, containing about 25 per cent. of arsenic, copper, and antimony. It is found in Peru, in small blackish-grey crystals, with a metallic lustre; and as an amorphous coating upon Quartz. Named after the Hon. J. R. Clay, United States Minister in Peru.

Clearstory or **Clerestory.** The upper range of openings in Gothic churches or buildings, interposed between the roof of the centre aisle and the roof of the side aisles.

Cleats. On Shipboard, are pieces of strong



wood, shaped somewhat like two anvils joined at their thick ends, round which ropes are wound. The cleat is fastened to the ship's side or other part by a pin through the centre. Some cleats, however, have but one arm.

Cleavage. In Geology, a term applied to 's capable of being split into parallel plates, indefinitely thin. The property of cleavage, in the strict sense of the word, is confined to argillaceous rocks, and of all these the slates show the most perfect specimens.

Mechanical compression appears to produce on substances exposed to it conditions so like those of cleavage, that it is hardly possible to resist the conclusion that to this cause chiefly the phenomenon is due.

Cleavelandite. A mineralogical synonym for Albite; named after Parker Cleaveland, of Bowdoin College, United States.

Cledge. A miner's term, applied to thin strata of clay or fuller's earth.

Clef (Fr.). In Music, a mark prefixed to a staff, showing the tone or key in which a piece of music is written; it is a letter or other sign marked on a line, which determines the name of all those of the degree whereon it is placed. A clef is always placed on a line, never on a space. [MUSIC.]

Cleft-grafting. A mode of grafting, in which the scion is inserted into a cleft made in the stock. [GRAFTING.]

Clepsydra (Gr. κλεψύδρα, from κλέπτω, *I steal*, and ὕδωρ, *water*). Water-clock; an ancient instrument for measuring time by the gradual emptying of a large vessel of water through an orifice of a determinate magnitude. Clepsydras were first brought into use in Egypt under the reign of the Ptolemies, and seem to have been common in Rome, though they were employed chiefly in winter; in summer sun-dials were used. Though clepsydras are attended with several inconveniences, the principal of which is the unequal rapidity of the flow caused either by a variation in the depth of the water in the containing vessel, or of temperature, or barometric pressure, they are nevertheless susceptible of considerable accuracy; and before the invention of clocks and watches, astronomers could depend only on clepsydras for measuring small portions of time. At present they are abandoned because pendulum clocks and watches are much more convenient, as well as infinitely more exact. In one case, however, it has been proposed to revive their use; namely, for the accurate measurement of very short intervals of time by the flowing of mercury from a small orifice in the bottom of a vessel kept constantly filled to a fixed height. The stream is intercepted at the moment of noting any event, and diverted aside into a receiver, into which it continues to run till the moment of noting any other event, when the intercepting cause is suddenly removed. The stream then flows in its original course, and ceases to run into the receiver. The weight of mercury received, compared with the weight of that which passes through the orifice in a given time, observed by the clock, gives the interval between the events. This ingenious application of the principle of the clepsydra is due to the late Captain Kater.

A form of water-clock has also recently been devised by the Astronomer-Royal for commu-

nicating the necessary motion to telescopes equatorially mounted.

Clergy (Fr. clergé). The ecclesiastical body as distinguished from the laity.

Clerk (Gr. κληρικός, Lat. clericus). The legal appellation of a clergyman. The clergy being exclusively the learned part of the community in the middle ages, the word hence came to signify an educated person; and thus acquired the sense of a scribe or writer in France and England.

Clew. In Naval language, is the lower corner of a square-sail.

Clew-garnets. Are the same as clew-lines; but the term is only applied in connection with the courses or lower sails.

Clew-lines. Are small ropes used to draw the sail up to the yard when the sail is *clewed up* in the act of shortening sail.

Clichy White. A pure carbonate of lead, or white-lead, manufactured at Clichy in France.

Clients (Lat. cliens, from the old word cluo, *I hear* or *obey*). In Ancient History, a numerous body of the Roman citizens, so termed relatively to their patrons or protectors. This relation was in many respects similar to that of a serf to his feudal lord, but bore a much milder form. It was the duty of the patron to watch over the interests of his clients and protect them from aggression, and appear for them in lawsuits. He also frequently made them grants of land on lease. In return, the client was bound to defend his patron, and contribute towards any extraordinary expenses he might be subject to; as the portioning his daughters, the payment of a fine imposed by the state, &c. He might not appear as accuser or witness against him in judicial proceedings, a prohibition which was reciprocal. The body of clients was increased by the institution by which foreigners, who, as allies of Rome, had a share in its franchise, might choose themselves patrons on their coming to settle in the city. The obligations of clients were hereditary, and could not be shaken off unless through the decay of the family of the patron. The clients have by some been distinguished from the plebeians; by others they have been regarded as plebeians who of their own will entered into certain relations with the patrician families. (Ihne, *Researches into the History of the Roman Constitution.*)

It has been seen that among the other duties of a Roman patron towards his client was that of maintaining his cause gratuitously in legal proceedings. Hence the term *client* has become appropriated in modern times to one whose cause is prosecuted or defended and his person represented by an advocate. The custom of practising gratuitously as advocates long prevailed among the Roman patricians; and from it the usage was derived, which still obtains among ourselves, of considering the fee of a counsel as 'quiddam honorarium,' a gratuity which cannot be legally claimed. At present, the etiquette of the English bar appears to be this: that a barrister cannot refuse, without strong grounds for such refusal, to undertake any cause which is offered him: that he cannot refuse, without reasonable excuse, to plead gratuitously the cause of a client who sues regularly 'in formâ pauperis;' or to defend a prisoner if called on to do so by the court; and that he can receive no instructions with a fee except through the medium of a regularly authorised agent of his client (attorney or solicitor). An application to a barrister with the customary fee, to undertake a cause in which he is not yet instructed, is called a 'retainer,' and secures his services for the client. An application to undertake all causes for a particular client is a *general* retainer.

Climacterical Year (Gr. κλιμακτηρικός, from κλιμακτήρ, *the step of a staircase*). Certain years in the life of man have been from great antiquity supposed to have a peculiar importance, and to be liable to singular vicissitudes in his health and fortunes. This superstitious belief is said to have originated in the doctrines of Pythagoras. The well-known notice of the climacterical year sixty-three, supposed to be particularly dangerous to old men, in a letter of Augustus Cæsar preserved by Aulus Gellius, evinces its prevalence among the Romans. This year has been called by some astrological writers 'heroicus,' as having been peculiarly fatal to great men. The virtue of this year seems to consist in its being a multiple of the two mystical numbers, seven and nine. It is certainly singular that usage should have attached in all countries peculiar distinctions to those years which are denoted by compounds of the number seven. Thus fourteen has been fixed for various purposes as the epoch of puberty, twenty-one of full age; thirty-five is selected by Aristotle as the period when the body is in its highest physical vigour. The same author supposes the vigour of the mind to be perfected at forty-nine: sixty-three to be the grand climacterical year; seventy the limit of the ordinary age of man. Bodinus says that seven is the climacterical number in men and six in women. The term *climacteric disease* has more lately been applied to that declension of bodily and vital powers which is frequently observed to come on in the latter period of life, and from which many persons again rally so as to attain extreme old age.

Climate (Gr. κλίμα, from κλίνω, *I incline*). Among the ancient geographers, was applied to denote that obliquity of the sphere with respect to the horizon which gives rise to the inequality of day and night. They divided the space comprehended between the equator and the pole into thirty parts, which they denominated *Climates* or *Inclinations*; viz. twenty-four between the equator and polar circle, and six between the polar circle and the pole. The first are called *half-hour* climates, because from one to another the longest day receives an augmentation of half an hour; the second are called *month* climates, because at the two parallels between which any one of them is

comprehended the difference of the time of perpetual sunshine is one month. The first half-hour climate reaches from the equator to that parallel of latitude where the length of the longest day is twelve hours and a half; the second ends at the parallel where the longest day is thirteen hours, and so on. If, therefore, from the number of hours in the longest day at any particular place we subtract twelve, the number of half-hours remaining will indicate the climate in which that place is situated. Thus, the longest day at London being a little more than sixteen hours and a half, London is situated in the tenth climate.

Climate, in its most ordinary and general acceptation, embraces all those modifications of the atmosphere by which our organs are sensibly affected: such as temperature, humidity, variations of barometric pressure, the tranquillity of the atmosphere or the effects of winds, the purity of the air or its mixture with gaseous emanations more or less salubrious; and lastly, the habitual diaphaneity of the atmosphere—that serenity of the sky so important on account of the influence which it exercises not only on the developement of organic tissues in vegetables and the ripening of fruits, but also on the *ensemble* of moral sensations which mankind experience in the different zones. There are two general causes on which the climate peculiar to any country principally depends—1st. Its distance from the equator; and 2nd. Its altitude above the level of the sea; but their effect is generally modified by many circumstances exerting a partial influence. Among these may be enumerated the configuration and extent of the country; its inclination and local exposure; the direction of the chains of mountains by which it is intersected, or which are in its vicinity; the nature of the soil as it is more or less favourable to radiation, absorption, and evaporation; the proximity to, or distance from, seas; the action of winds blending the temperatures of different latitudes; and even the changes produced by cultivation. The appreciation of all these causes, which modify the results deduced from the consideration of latitude and elevation alone, and the effect produced by their combined operation, constitutes the science of *climatology*.

Effect of Geographical Position.—Other things being equal, the temperature enjoyed by any country depends on the heat which it receives directly from the sun. In estimating the amount of solar heat received by any given space on the surface of the earth in the course of a whole year, we may suppose the sun to remain constantly in the equator, because the excess of heat above the mean in summer is exactly balanced by its defect in winter. Now, the effect produced on any given portion of the surface will depend on the number of rays that fall on that surface, and on the obliquity of their direction with respect to it. But the number of rays falling on a zone of any given breadth, a degree for example, is proportional to the cosine of its latitude; and the effect of a single ray in consequence of its oblique impact is diminished also in proportion to the cosine of the latitude; the diminution of the mean temperature, therefore, in going from the equator to the poles, must be proportional to the square of the cosine of the latitude. It hence follows that the variations of the mean temperature must be most rapid about the middle latitude of 45°; and this result of theory agrees perfectly with observation. Within the temperate zone the character of the climate changes rapidly. Thus, in the South of France, and in Italy, nearly under the 45th parallel, the region of the vine is found contiguous to that of the olive and fig-tree. On the other hand, very little increase of heat is observed from the tropic to the equator; and at the other extremity of the arc, from the arctic circle to the highest latitude that has been reached, the intensity of cold is not greatly augmented. The law of the square of the cosine gives a variation of only about eight degrees of Fahrenheit's scale from the polar circle to the pole. In the system of climates of Western Europe, the mean temperature at the latitude of 45° is about 13° or 13·5° of the centigrade scale (55° to 56° of Fahrenheit). The mean temperature under the equator ought therefore to be, by the theory, 26° or 27° (centigrade); and at any other place it will be found by multiplying the constant number 27 into the square of the cosine of the latitude.

Effect of Altitude.—That a greater degree of cold prevails in the upper regions of the atmosphere than at low levels would be manifest by the snowy covering of the summits of very elevated mountains in all latitudes, even if no direct experiments had been made on the temperature that prevails there. These, however, have been made in great number; and the constant and regular decrease of the temperature in ascending above the surface of the earth, to such altitude at least as can be reached, has not only been fully established, but the law according to which the decrease takes place determined with considerable certainty. According to theory the decrements of heat in ascending the higher regions should follow the same proportion as the decrements of the density; but this law is greatly disturbed by local peculiarities. The variation of temperature at different altitudes is caused in the following manner: the rays of *luminous* heat from the sun pass through a clear atmosphere, with but little loss from absorption; they therefore exercise but little heating effect upon the air. When these rays strike the earth, they are absorbed, and the surface, be it land or water, becomes heated, and begins to emit rays of *obscure* heat. The latter pass easily through absolutely dry air, but are arrested, as Professor Tyndall has shown, by the aqueous vapour which is almost invariably present in the lower strata of the atmosphere. Hence these rays of obscure heat are intercepted chiefly by the air near the surface of the earth, which therefore be-

comes warmer than the superincumbent strata. But this warmer air ascends, and might therefore be expected to mix with the colder air above, and thus produce an approximately uniform temperature; but the ascent of the warm air involves the performance of mechanical work, which necessitates the disappearance of heat. Thus the air becomes colder as it ascends, and if it start from the surface of the earth with a temperature of 80° Fahr. it may be cooled to the freezing point of water by the time it has reached a height of 15,000 feet. In the torrid zone, Humboldt, from a mean of many observations, found that between the altitudes of 3,000 and 5,800 mètres (9,840 and 19,000 feet) an increase of elevation, amounting to 191·4 mètres, produced a diminution of 1° of the centigrade thermometer. This corresponds to 349 English feet for 1° Fahr. Professor Leslie (*Ency. Brit.* art. 'Climate') estimates that the diminution of temperature of 1° of Fahrenheit's scale corresponds to an ascent of 300 feet. But this will hold true only of moderate elevations. At the altitudes of 1 mile, 2 miles, 3 miles, 4 miles, and 5 miles, the increase of elevation corresponding to 1° Fahr. will be respectively 295, 277, 252, 223, and 192 feet. The allowance of 1° of Fahr. for every 100 yards of ascent is, however, a rule of easy recollection, and in ordinary cases may be taken as a sufficient approximation.

Effect of large masses of Water and of general Configuration.—The form of the boundaries of any large mass of land as determined by its contact with the ocean, that is to say, the greater or less extent of coast it possesses in proportion to its area, exercises a considerable influence on the climate. The small amount of variation in the temperature of the ocean tends to equalise the periodic distribution of heat among the different seasons of the year, and the proximity of a great mass of water moderates by its action on the winds the heat of summer and the cold of winter. Hence the great contrast between the climate of islands and coasts, and the climate of the interior of vast continents. Europe presents a remarkable example of this contrast. From Orleans and Paris to London, Dublin, Edinburgh, and even farther north, the mean temperature of the year decreases very little, notwithstanding the increase of latitude; while in the eastern part of the Continent each degree of latitude, according to Humboldt, produces a variation of 1·1° Fahr. in the mean temperature. A small island, a tongue of land, or an indented coast, in contact with a great mass of water, which preserves in winter a considerable portion of the heat acquired during the summer, possesses a more moderate climate, milder winters, and fresher summers, and in the higher latitudes a somewhat higher mean temperature, than the interior of great continuous masses of land under the same latitude. The diminution of the mean annual temperature from the western shores of Europe to beyond the meridian of the Caspian is remarkable. Amsterdam and Warsaw are situated very nearly under the same parallel of latitude, that of the first being 52° 22′, and that of the second 52° 14′; but the mean annual temperature of Amsterdam is 53·4° Fahr., while that of Warsaw is only 46·48°. The latitude of Copenhagen is 55° 41′, and that of Kasan 55° 48′; but the mean annual temperature of Copenhagen is 45·7°, that of Kasan 37·6°.

Proximity to large masses of water also involves the presence of much aqueous vapour in the atmosphere. Speaking of the influence of this aqueous vapour on climate, Professor Tyndall says:—

'Aqueous vapour is a blanket more necessary to the vegetable life of England than clothing is to man. Remove for a single summer night the aqueous vapour from the air which overspreads this country, and you would assuredly destroy every plant capable of being destroyed by a freezing temperature. The warmth of our fields and gardens would pour itself unrequited into space, and the sun would rise upon an island held fast in the iron grip of frost. The aqueous vapour constitutes a local dam, by which the temperature at the earth's surface is deepened: the dam, however, finally overflows, and we give to space all that we receive from the sun.

'The sun raises the vapours of the equatorial ocean; they rise, but for a time a vapour screen spreads above and around them. But the higher they rise, the more they come into the presence of pure space, and when, by their levity, they have penetrated the vapour screen, which lies close to the earth's surface, what must occur?

'It has been said that, compared atom for atom, the absorption of an atom of aqueous vapour is 16,000 times that of air. Now the power to absorb and the power to radiate are perfectly reciprocal and proportional. The atom of aqueous vapour will therefore radiate with 16,000 times the energy of an atom of air. Imagine, then, this powerful radiant in the presence of space, and with no screen above it to check its radiation. Into space it pours its heat, chills itself, condenses, and the tropical torrents are the consequence. The expansion of the air, no doubt, also refrigerates it; but in accounting for those deluges, the chilling of the vapour by its own radiation must play a most important part. The rain quits the ocean as vapour; it returns to it as water. How are the vast stores of heat set free by the change from the vaporous to the liquid condition disposed of? Doubtless in great part they are wasted by radiation into space. Similar remarks apply to the cumuli of our latitudes. The warmed air, charged with vapour, rises in columns, so as to penetrate the vapour screen which hugs the earth; in the presence of space, the head of each pillar wastes its heat by radiation, condenses to a cumulus, which constitutes the visible capital of an invisible column of saturated air.

'Numberless other climatal phenomena receive their solution by reference to the radiant and absorbent properties of aqueous vapour.

It is the absence of this screen, and the consequent copious waste of heat, that causes mountains to be so much chilled when the sun is withdrawn. Its absence in Central Asia renders the winter there almost unendurable; in Sahara the dryness of the air is sometimes such, that though during the day 'the soil is fire and the wind is flame,' the chill at night is painful to bear. In Australia, also, the thermometric range is enormous on account of the absence of this qualifying agent. A clear day and a dry day, moreover, are very different things. The atmosphere may possess great visual clearness, while it is charged with aqueous vapour, and on such occasions great chilling cannot occur by terrestrial radiation. Sir John Leslie and others have been perplexed by the varying indications of their instruments on days equally bright; but all these anomalies are completely accounted for by reference to this newly-discovered property of transparent aqueous vapour. Its presence would check the earth's loss; its absence, without sensibly altering the transparency of the air, would open wide a door for the escape of the earth's heat into infinitude.' (*Royal Institution Discourse*, Jan. 23, 1860.)

The climate of a country is influenced not only by its horizontal configuration, but also by its *relief*, or vertical configuration. Mountains affect the climate of the adjacent plains in various ways—by the reverberation of heat from naked rocks; by affording shelter from certain predominating winds; and by giving rise to descending currents of cold air from the higher regions of the atmosphere, in consequence of the disturbance of the equilibrium of heat produced by the radiation from their sides and summits. The local exposure of a country also, or its inclination to or from the equator, which may be included under the title *configuration*, has a powerful influence on its mean annual temperature. Generally speaking, the local exposure is connected with and depends upon the position of the mountain chains, and both conspire to increase or diminish the mean temperature at the same time. For example, when the general inclination of an extensive tract of country in the northern hemisphere is towards the south, the northern side is bounded by ranges of mountains; so that while the sun's rays fall upon it at a less oblique angle, it is sheltered from the cold winds blowing from a higher latitude.

Climate of Europe.—In a general view, Europe may be regarded as a peninsular prolongation of the ancient continent, broken and intersected by numerous arms of the ocean, and by inland seas. The predominating winds are from the west; and these, for the whole of the western portion, are sea winds, greatly softened by blowing over a mass of water, of which the superficial temperature, even in the month of January, at the parallels of 45° and 50°, does not fall below 48° and 51° of Fahrenheit. It is placed directly north of an immense tract of tropical land (Africa and Arabia), which by its diurnal radiation contributes powerfully to elevate the temperature. On the northern side the cold belonging to the latitude is mitigated by numerous favourable circumstances. A very small portion of land lies within the polar circle; and the whole of the northern extremity is separated from the polar ice by a zone of open sea, the temperature of which is maintained at a considerable elevation in consequence of its communication with the Atlantic Ocean, and of the existence of the Gulf Stream, which conveys a portion of the warmth of the gulf of Mexico into the polar seas, and to the western shores of the British Islands.

Climax (Gr. *a ladder*). In Rhetoric, a figure by which several propositions, or several objects, are placed before the mind of the hearer or reader in such an order that the proposition or object calculated to produce the least impression shall strike it first, and that the rest shall follow in regular gradation. *Anti-climax* is the converse figure, in which the ideas sink in succession. This forms a principal cause of that vice of composition of which so many ludicrous illustrations have been given under the name of *bathos*.

Clinanthium (Gr. *κλίνη, a bed*, and *ἄνθος, a flower*). In Botany, a term used to express the receptacle of a Composite plant. It is the dilated apex of a flowering branch covered over by small flowers enclosed within an involucre.

Clinical (Gr. *κλινικός, belonging to a bed*). This term is generally used medically; a *clinical lecture*, for instance, is the instruction which the teacher gives his pupil at the bedside of the patient.

Clinium (Gr. *κλίνη*). A term occasionally used in Botany to denote the summit of a floral branch, of which the carpels are the termination. It is the same as the *torus* of the modern French school, and one of the parts called *receptacle* by Linnæus, as in the strawberry.

Clinkers. [Bricks.]

Clinochlore (Gr. *κλίνω, to incline*, and *χλωρός, green*). A hydrated silicate of alumina, iron, magnesia, &c., found in crystals and plates of an olive-green colour, with a micaceous structure and pearly lustre, at Leugast in Bavaria, Achmatowsk in the Ural, and in Pennsylvania.

Clinoid (Gr. *κλίνη*, and *εἶδος, likeness*). This term has been improperly applied to certain processes of the *sphenoid bone*.

Clinometer (a word coined from Gr. *κλίνη*, and *μέτρον, a measure*). An instrument constructed to enable a geological observer to determine the dip of beds.

Clintonite. A hydrated silicate of alumina, magnesia, lime, soda, peroxide of iron, &c., found at Amity in New York, and named after Mr. De Witt Clinton. [Brandisite.]

Clio or **Cleio.** In Greek Mythology. One of the nine Muses. (Hesiod. *Theogony*, 50–104.) In later times she was looked upon as the Muse of History.

CLIO. In Zoology, applied by Linnæus to a genus of *Vermes*, and by Cuvier to a genus of Pteropodous Molluscs; one species of which, the *Clio borealis*, abounds in the northern seas, and although not exceeding an inch in length, forms a great proportion of the food of the whalebone whale, *Balæna Mysticetus*.

Clipper (a word probably introduced in America, from the verb *to clip*, in the sense of *to divide* or *cleave*). A cargo ship, especially constructed for speed. They were built in the first instance for the conveyance of perishable goods, and the fruit-clippers and slave-clippers became known as the fastest vessels afloat. Of late years the finest clippers are those of Liverpool and American build, which are employed in the Atlantic and Australian traffic. Clippers are usually of a sharp form, with finely curved bows and generally an elliptical shape, having a deep keel and lofty masts. Some of the finest of these vessels have made the voyage to Australia as rapidly as the mail steamers.

Cloaca (Lat.). The excrementory cavity in which, in birds, reptiles, many fishes, and some mammals, the intestinal canal, urinary ducts, and genital passages terminate.

Clock. [HOROLOGY.]

Cloister (Ger. kloster, Lat. claustrum, from claudo, *I shut*). In Architecture, this term is usually applied to the covered walk, ambulatory, or passage from one principal part of a conventual building to another; or, in fact, a colonnade round an open court.

Close-burning Coal. The term *close-burning* is applied to those strong-burning, blazing descriptions of bituminous coal which, from their tendency to swell in the fire and form a more or less coherent pasty mass, prevent a free draught of air in the furnace, and have to be coked before they are used. [CAKING COAL and OPEN-BURNING COAL.]

Close-hauled. In Navigation, the tacks close down, the sheets aft, the yards braced sharp up, and the bowlines hauled, the ship making her progress as near the direction of the wind as she can.

Closers. In Architecture, the pieces (or batts) less or greater than half a brick that are used to close in the end of a course of brickwork. In Flemish bond [BOND] the length of a brick being but nine inches, and its width four inches and a half, a quarter brick (or batt) must be interposed to preserve the continuity of the bond; this is called a *queen closer*. A similar preservation of the bond may be obtained by inserting a three-quarter batt at the angle in the stretching course; this is called a *king closer*. In both cases a horizontal lap of two inches and a half is left for the next header. The term is also applied to mason's work, and it signifies in that case the piece of stone introduced to fill up a course of ashlaring around a building in such a manner as to secure the breaking of the vertical bond.

Cloud. A visible mass or collection of minute particles of water suspended in the atmosphere. Clouds differ from fogs or mists only in occupying a more elevated position; in all cases the origin is the same, namely, the vapours which rise from collections of water, and indeed from the whole surface of the earth. These aqueous vapours are condensed in the higher and colder regions of the atmosphere, and thus lose their transparency and become visible. Clouds differ very greatly in respect of form, magnitude, density, &c. These differences depend on the quantity of vapour of which they are composed, and the situations which they take as they unite with one another; and are determined in a great measure by the direction and velocity of the motion communicated to them by the wind. The height at which they float in the atmosphere is determined by their specific gravity, and consequently varies with their density. Thin light clouds are observed higher than the summits of the loftiest mountains, while those which are dense and thick rise only to a small distance above the surface of the earth. It is very difficult to determine their average elevation: it is supposed to be between two and three miles, but it varies at different times of the year.

Clouds were distributed by Mr. Luke Howard into three primary formations—the *Cirrus*, the *Cumulus*, and the *Stratus*. But besides these he admitted four other varieties—the *Cirro-cumulus*, the *Cirro-stratus*, the *Cumulo-stratus*, and the *Cumulo-cirrostratus* or *Nimbus*. The *Cirrus* consists of fibres or curling streaks, which diverge in all directions. It occupies the highest region, and is frequently the first cloud which is seen after a continuance of clear weather. The *Cumulus* is a convex aggregate of watery particles, increasing upwards from a horizontal base, and assuming more or less of a conical figure. The *Stratus* consists of horizontal layers, and comprehends fogs and mists. It is the lowest of the clouds, its under surface usually resting on the earth or water. The *Cirro-cumulus* is intermediate between the cirrus and cumulus, and is composed of small well-defined masses closely arranged. The *Cirro-stratus*, intermediate between the cirrus and stratus, consists of horizontal masses separated into groups, with which the sky is sometimes so mottled as to suggest the idea of resemblance to the back of the mackerel. The prevalence of the cirro-stratus is usually followed by bad weather. The *Cumulo-stratus*, or *twain cloud*, partakes of the appearance of the cumulus and stratus or cirro-stratus. The *Nimbus*, or *rain cloud*, is that into which the others resolve themselves when rain falls.

The above nomenclature is sufficiently fanciful; nevertheless it enables the meteorologist to convey more precise ideas in describing the diversified forms under which masses of clouds present themselves, and their connection with the changes of the weather. These forms are, however, frequently so indefinite and shapeless, that it is difficult, if not impossible, to refer them to any one of the preceding modifications.

A tendency, however, to one or other of them may in general be traced. (Howard's *Arrangement and Nomenclature of Clouds*, in the 16th and 17th vols. of the *Philosophical Magazine*; Foster *On Atmospheric Phenomena*; Murray's *Encyclopædia of Geography*, p. 168; *Companion to the British Almanac* for 1830, &c. See also Dalton's *Meteorological Essays*, 1793.)

Clouted or Clotted Cream. The cream produced, in Somersetshire and Devonshire, by setting a pan of new milk on a hot hearth.

Cloves. The unexpanded flower-buds of the *Caryophyllus aromaticus*, a low branching myrtaceous tree cultivated in the Dutch settlements in India. The finest cloves are from Amboyna; they are of a bright brown colour, extremely fragrant, and hot and acrid upon the tongue; they abound in essential oil, which may be pressed out of their pores by the nail, and which is generally obtained by distillation with water, to the amount of from fifteen to twenty per cent. It is sold in commerce under the name of *oil of cloves*, and is chiefly used in medicine, and occasionally in perfumery. The fruit of the clove-tree was employed in old pharmacy under the name of *anthophylli.*

CLOVES. In Botany, the smaller bulbs formed in the axillæ of the scales of a mother bulb, as in garlic.

Club Moss. A name applied to *Lycopodiums*. The seeds of one species, *L. clavatum*, which are very minute, and resemble an impalpable yellow powder, are used in theatres to imitate lightning; when thrown across a flame, they produce a sudden flare. They contain a peculiar oil.

Club-hauling. In Navigation, a critical mode of tacking, resorted to only in perilous situations, when a ship has no other escape from running ashore. It consists in letting go the lee-anchor as soon as the wind is out of the sails, thereby bringing the ship's head to wind. She will then pay off, when the cable is cut and the sails are trimmed. By this process the tack is accomplished in a far shorter distance than it could otherwise be.

Clubbing. A hypertrophy of the roots of plants, chiefly of the cabbage and other *Brassicaceæ*, in which the root becomes roughly swollen and marbly like a truffle. On some ground, chiefly that which is exhausted by long cultivation, cabbages are very liable to suffer in this way, the growth of the stem being arrested. The best remedy is wood ashes dropped in the hole when the plant is put in.

Clump. The compressed clay of coal strata.

Clunch. In Geology, the hard and often dirty-looking bed of the lower chalk. When not exposed to weather, this material is well adapted for decorative purposes in architecture. Many of our cathedrals show good specimens that have retained their sharp edges for centuries. In the clunch the silicious particles that were removed to form beds of flint in the white upper chalk are generally found disseminated among the chalk itself, giving it a greyer colour and harsher feel. It rests on the upper greensand (an arenaceous bed), and often contains clay.

Cluniacs. In Ecclesiastical History. An order of monks, so called from the abbey of Clugny, on the Saône, founded by St. Bernon early in the tenth century. There were many houses of this order in England before the dissolution of monasteries. (Hook's *Church Dictionary*; Milman's *Latin Christianity*, bk. viii. ch. iv.)

Clusia (after De l'Écleuse, an eminent French botanist). A genus of *Guttiferæ*, or *Clusiaceæ* as it is sometimes called, chiefly distinguished by its capsular five or ten celled fruit, and by the numerous stamens which open by their whole length. They are tropical trees, and one of them, *C. Galactodendron*, a native of Venezuela, is one of the Cow-trees (Palo de Vaca) of South America. The milk flows from incisions made through the bark to the wood, one tree yielding about a quart in an hour.

Clutches or **Glands.** In Machinery, couplings which have no coupling boxes are denominated *clutches* or *glands*. A coupling of this kind consists of two crosses, one fixed to the end of each of the shafts to be connected. One of the crosses, having its end bent forward, lays hold of, or *clutches*, the other, and by doing so turns round the other shaft. Instead of cross pieces two round cast-iron plates are sometimes used, each having a part cut out, and a corresponding projection. The projection of the one plate is inserted in the opening of the other, and thus serves to engage the shafts. (Buchanan *On Mill Work.*)

Clypeaster (Lat. clypeus, *a buckler*, and astrum, *a star*). A genus of sea-urchins (*Echinidæ*) of a flattened shield-like form, with a submarginal vent. This genus is termed *Echinanthus* by Klein.

Clypeate (Lat. clypeatus, from clypeus). Shield-like, or scutate.

Clyssus. An alchemical name for the water obtained by deflagrating nitre with charcoal: the vessels were generally burst in the operation; but when it succeeded, the few drops of water obtained were highly prized for medical use.

Coacervate (Lat. coacervatus, part. of coacervo, *I heap together*). Accumulated. A term applied by older physiologists to certain secretions or excretions long retained.

Coadjutor (Lat. co, and adjutor, *a helper*). In Ecclesiastical matters, the assistant of a bishop or other prelate (in some instances even of a canon or prebendary, but the latter usage was irregular). A coadjutor was equal in rank to the dignitary whose functions he might on occasion supply; hence the coadjutor of a bishop was himself consecrated a bishop *in partibus infidelium*. The celebrated cardinal de Retz was known by the title of the Coadjutor of Paris during the most active period of his career, having the administration of the temporalities of that see, which belonged to his uncle the archbishop de Retz. Coadjutors usually succeeded their principals in their

dignities; and hence arose an abuse which tended to make ecclesiastical dignities hereditary, nephews and other relatives of bishops being named their coadjutors. The institution of coadjutors to bishoprics is preserved by the French concordat of 1801.

Coadunate (Lat. coadunatus, part. of coaduno, *I unite*). In Botany, two or more parts joined together.

Coagulable Lymph. A term given in some surgical works to the fibrine of the blood, which is the only part that has the power of spontaneously coagulating.

Coagulum (Lat.). The part of the blood which changes from the fluid to the solid state, when drawn from the body and left at rest, or subjected to heat or certain chemical reagents. It consists of the fibrine with the blood-discs.

Coal (Ger. kohle). This remarkable and well-known mineral consists essentially of carbon combined with certain gases and mixed with certain earthy impurities, which affect its value for practical purposes and sometimes alter its appearance.

The essential characters of coal in Practical Geology are derived from its colour, texture, composition, and uses as a combustible. The associated rocks are not unimportant; and the thickness and number of the coal seams within certain limits greatly affect the value of a deposit.

Coal differs from most rocks very distinctly. Some black minerals, such as obsidian, black quartz, and others, resemble it, but are distinguishable in a moment by texture, and also by their being non-combustible. There is, however, a rock into which it passes by gradations which are often hardly perceptible. [BITUMINOUS SHALE.] Generally alternating with shale or hard clayey bands, these have not unfrequently obtained from the coal so much carbon and of various hydrocarbons as to be quite black, and even to burn with facility, though with a large percentage of ash. It is sometimes not easy to determine to which of the two rocks a given specimen belongs.

Of coals there are many kinds. ANTHRACITE is the richest in carbon; STEAM COAL contains sufficient gas to burn with flame, and get up steam economically, but is not rich in gas; the ordinary *bituminous caking coals* are sufficiently rich in gases to be useful for destructive distillation if required, but equally useful for house fires and all the ordinary purposes of fuel; the CANNEL COALS are so rich in gas as to be uneconomical except for the manufacture of gas; and the very richly bituminous coals of Scotland, the minerals called BOGHEAD COAL, TORBANE-HILL MINERAL, LISMAHAGO COAL, and some others, approach so nearly in all respects to the condition of bituminous shales that they are far more valuable for slow distillation to procure oils and paraffine, than directly as fuel or for destructive distillation to make coke and gas.

Coal is very widely distributed over the earth. It is found in all the principal divisions of the globe, and is of all geological ages. Whatever its origin may have been, it is certainly a mineral that has been in course of formation since the existing state of the world began. It probably is so still. Silurian coals have not indeed yet been found, though strong indications exist of large deposits of carbon of that period. Devonian coal is abundant. The carboniferous series is that which yields the chief supplies in Western Europe and Eastern North America. Permian coal is probable. Liassic coal abounds, and the whole of the oolitic series seems to contain carbonaceous deposits, as we advance towards the East. Cretaceous coal occurs at intervals in Hungary and the East, not indeed so good as could be desired, but still true coal, and excellent beds of true coal of the older tertiary period are found in mountain valleys of the Carpathians. Besides these are the enormous deposits of lignite or brown coal, widely spread in various parts of the world, but generally of tertiary date.

Coal is usually interstratified with clayey beds converted into shale and with sandy beds converted into sandstone or grit, and both of these usually show vegetable impressions, proving the near vicinity of land at the time of the deposit. The structure of coal itself also shows here and there distinct proof of vegetable origin; but whether in all cases the coal is an accumulation of decomposed and altered leaves and trees, or whether it has been so far altered before being deposited as to have lost most part of its structure, has not been clearly determined. Certainly the indications of vegetable tissue and cell-structure are not universal, though common, in prepared specimens examined under the microscope. Thus the true origin of the great deposits of coal remains obscure, though indirectly there can be no doubt that vegetation is the material that they were derived from.

But the changes involved in passing from the ordinary state of vegetable matter to the condition of coal are neither few, small, nor easily comprehended. The whole of the carbon remains, but other substances by no means unimportant, which help to form woody fibre, are generally absent. The best coal contains no water, no potash, no phosphorus, and very little silica, lime or iron, or if at any time it does contain such elements, the quantity is (with the exception of silica, lime and iron) absolutely inappreciable by the best chemical tests, whereas the proportion of these in wood and leaves varies from ·2 to nearly 12 per cent., and the water, potash, and phosphorus are essential ingredients. On the other hand, sulphur is not unfrequently present with iron in coal, and this element is only rarely found in certain succulent vegetables, and is then without iron. The change then from common vegetation to coal is complete, and involves an amount of decomposition little short of destruction.

The quantity of coal present in different coal fields is a matter of calculation; but it is clear

Coccinite. A protiodide of mercury resembling Cinnabar, found in reddish-brown particles, on selenide of mercury, at Casas Viejas in Mexico.

Coccolite (Gr. κόκκος, *a grain*, and λίθος, *stone*). A kind of Pyroxene, found in small translucent granules of various shades of green, which are slightly coherent, and hard enough to scratch glass. It is chiefly met with in the iron mines of Sweden and Norway.

Coccoon or **Cocoon.** The silken case which the larvæ of certain insects spin for the purpose of a covering during the period of their metamorphosis, and which some spiders prepare as a protection to their ova during the developement of the young. The cod or coccoon of the silkworm is a well-known example of the most valuable of these productions.

Coccosteus (Gr. κόκκος, *berry*, and ὀστέον, *bone*). A genus of Placoganoid Devonian fishes in which the external ganoid surface of the buckler plates is ornamented with small hemispherical tubercles, whence the generic name. In all the palæozoic fishes the cylindrical gelatinous body called *notochord* or *chorda dorsalis*, pre-existing to the formation of the bony bodies of the vertebræ in all vertebrate animals, is never developed beyond the soft embryonal state; such fishes are accordingly termed *notochordal* as retaining the notochord.

Cocculus Indicus. The fruit of the *Anamirta Cocculus*. It is imported from the East Indies, and contains a poisonous principle, which has been termed *picrotoxia*. It is often used to poison fishes: a few handfuls of it ground into coarse powder, and thrown into a pond, bring the fish, in the course of a few hours, to the surface in an intoxicated or poisoned state; but if quickly removed into fresh water, they recover. It is sometimes added to ale to increase its stupefying quality.

Coccum. In Botany, a term applied by Gærtner to denote a pericarp of dry elastic pieces or cocci, as in *Diosma*, &c.

Coccus (Lat. coccum, *scarlet*). A name given by Linnæus to a genus of Hemipterous insects, including the Mexican species, the cochineal insect (*Coccus Cacti*, Linn.), which feeds on *Cacteæ*, and which affords the well-known fine red dye.

Cochineal. The *Coccus Cacti*. This valuable insect was first introduced into Europe about the year 1523. It is imported from Mexico and New Spain. It feeds on several species of cactus. It is small, rugose, and of a deep mulberry colour. They are scraped from the plants into bags, killed by boiling water, and dried in the sun. Those are preferred which are plump, of a peculiar silvery appearance, and which yield a brilliant crimson when rubbed to powder. Cochineal is sometimes adulterated by the admixture of a manufactured article composed of coloured dough. This is detected by the action of boiling water, which dissolves and disintegrates the imitation, but has little effect upon the real insect. The principal component of cochineal is a peculiar colouring matter, which has been called *carminium* and *cochinelia*. It is obtained by digesting the powder of cochineal first in ether, which takes up fat, and then in alcohol, which dissolves the cochinelia. Acids change its colour from crimson to an orange-red, and alkalies turn it violet. When mixed with recently precipitated alumina, it forms a beautiful lake. Cochineal yields a brilliant scarlet dye, which is produced by fixing the colouring matter of the insect by a mordant of alumina and oxide of tin, and exalting the colour by the action of supertartrate of potash.

Cochlea (Lat. *shell*). In Anatomy, a portion of the internal ear, which in mammals is shaped like the common snail-shell, with its base resting on the bottom of the internal meatus, and perforated to receive some filaments of the acoustic nerve. It is traversed by a conical column, called *modiolus*, around which a *spiral canal* makes two turns and a half. This canal is divided into two ramps, or *scalæ*, by a partition of bone called the *lamina spiralis*. At the base of the cochlea one scala communicates with the vestibule, the other with the tympanum; they communicate with each other at the apex of the cochlea.

Cochlear (Lat. *a spoon*). In Botany, a term used in describing the æstivation of a flower, to express one piece being larger than the others, and hollowed like a helmet or bowl, covering all the others, as in *Aconitum*, &c.

Cochleate (Lat. cochlea, *a shell*, *a cockle*). In Botany, a term used in describing the general form of bodies, to denote any that are twisted in a short spire, so as to resemble the convolutions of a snail-shell; as the pod of *Medicago cochleata*. It also means a concave body like that of one of the valves of a cockle-shell, as in *Epidendrum cochleatum*.

Cocinic Acid. When the solid fatty matter of cocoa-nut oil is saponified, the crystalline fatty acid into which it is converted has been called *cocinic* or *cocostearic* acid.

Cock-pit. The after part of the orlop deck, or deck below the lower deck, and altogether below the water. Here, in line-of-battle ships, are the cabins of several of the junior officers. The cock-pit is appropriated to the use of the wounded in time of action.

Cock-pit. The name given to the place where game cocks fight their battles. The room in Westminster in which her majesty's privy council hold their sittings is called the *cock-pit*, from its having been the site of what was formerly the cock-pit belonging to the palace at Whitehall.

Cock-up Letter. In Printing, a large type used for the first letter of the first word of a volume, part, book, or chapter. The bottom of the type must range with the foot of the other types in the line, otherwise it is called a *drop* or *two-line letter*.

Cocket. In Commerce, a scroll of parchment, signed and delivered by the officers of the custom-house to merchants upon entering

their goods, to certify that their merchandise is customed and may be discharged.

Cockney. A contemptuous appellation for a citizen of London. If the origin of the term be doubtful, its antiquity cannot be disputed, as it is mentioned in some verses generally attributed to Hugh Bagot, earl of Norfolk, in the reign of Henry II.:—

Were I in my castle at Bungey,
Upon the river of Waverney,
I would ne care for the king of Cockeney (i.e. of London).

Cocoa. The fruit of the *Theobroma Cacao*, which is about the size of a kidney-bean, and enclosed in a thin shell.

Cocos (Port. coco, *a monkey*, from the resemblance of the end of the nut to a monkey's head). The Cocoa-nut tree, *C. nucifera*, is the type of this genus of palms, which mostly occurs in the tropical regions of America. The common Cocoa-nut, however, though now cultivated throughout the tropics, is supposed to be a native of Southern India. It prefers the vicinity of the sea, and hence probably its wide distribution. It forms a trunk 60 or 100 feet high, with a crown of pinnate leaves and branching spikes of from 12 to 20 fruits, three-sided with an outer fibrous husk enclosing a single seed contained in a hard shell, which is the form in which it is commonly known in this country. The uses of this palm are very numerous, every part being put to some purpose. The nut itself, the oil, and the fibre (called *coir*) are the principal products of the fruit; the trunk yields timber, and the leaves form mats, baskets, and thatch; while the sap yields toddy and palm sugar.

Cocytus (Gr. *κωκυτός*, *lamentation*; from *κωκύω*, *I bewail*). In Mythology, one of the rivers of Hades; according to Homer, a branch of the Styx. (*Odyssey* x. 513.)

Cod Liver Oil. The oil obtained from the liver of the common cod (*Morrhua vulgaris*), and other allied species, has long been a popular remedy for rheumatism and some other complaints, but its use by medical practitioners is of comparatively recent date. The London market is almost entirely supplied with this article from Newfoundland, where the fishing begins in June and ends in October. The livers are either pressed or they are boiled in water, and the oil afterwards filtered, the colour of it varying according to the mode of preparation and the species of fish from which it is derived. Besides the usual constituents of fish oil, traces of bromine and of iodine (iodide of copper) are said to have been discovered in it, and to these agents its efficacy may perhaps be ascribed, though it has often been doubted whether it possesses any virtues beyond those of the fat oils in general. In the dose of a tablespoonful or two daily, it generally acts slightly on the bowels; and though nauseous and disagreeable at first, the repugnance to it is soon overcome. Rheumatism, scrofula, chronic gout, skin affections, phthisis, and mesenteric emaciation are the diseases in which it has been principally prescribed. One or two tablespoonfuls twice or three times a day for adults, and a teaspoonful night and morning for young children, are the usual doses. Coffee, warm table-beer, dill, peppermint, and other aromatic waters, are the best vehicles for covering its nauseous flavour.

Coda (Ital. *a tail*). In Music, the passage which serves to close or end a movement, after the regular form has been completed. In some cases it consists of merely one phrase, in others it is carried to a great extent. At the conclusion of a canon, it often serves to end the piece which might otherwise be carried on to infinity.

Code (from the Latin codex, *a manuscript*). Signifies, in the language of Jurisprudence, any collection of laws digested and reduced into an orderly arrangement, whether by public authority or by the private labour of learned men. But, in the ordinary sense, the word *code* is only used to signify a compilation of laws by authority. Five collections of Roman law are designated by the title of *codes*: that of Sextus Papirius, which only exists in fragments discovered by various authors, but which contained the laws of the Roman kings; the Gregorian, the compilation of an unknown author, about the reign of Constantine; the Hermogenian, of which the author is also doubtful, and the date nearly the same; the Theodosian, framed under the order of the emperor Theodosius the younger, and containing the constitutions of the emperors from the time of Constantine to his own (from which, until the greater works of Justinian became publicly known in modern Europe, the jurisconsults of the dark ages drew the greater part of their knowledge of Roman law); and, lastly, that of Justinian, A.D. 529. Of the codes of law now recognised in modern states the most remarkable are, in order of time: the code of Frederick the Great of Prussia; that of Catherine of Russia, confined to criminal jurisprudence; that of Joseph II. of Austria; and the Code Napoléon in France. This title, though sometimes given in general language to all the digests of law made under that emperor, is appropriated by French lawyers to the greatest of his works, the Code Civil. The project for this code was drawn up, in 1801, by five commissioners, by them reported to the Court of Cassation, and thence carried to the Conseil d'État: in that body it was fully discussed, clause by clause. Besides the Code Civil, the written French law now comprises seven other 'principal' codes; viz. the Code Pénal; the two Codes of Procedure, civil and criminal; the Code de Commerce; the Code Rural, Forestier, and 'de Pêche Fluviale.' Other collections of laws on special subjects are sometimes, but less accurately, termed, in France, *codes*; e.g. the Code Politique, Militaire, &c.

Codeine or **Codeia** (Gr. *κώδεια*, *the poppy head*). An alkaline substance, discovered in 1832 by Robiquet in opium. It was at first confounded with morphia.

Codetta (Ital. dim. of coda). In Music, a short passage which connects one section with another, and not composing part of a regular section.

Codex (Lat.). A manuscript: in its original sense the inner bank of a tree, which was used for the purposes of writing. The word was thence transferred by the Romans to signify a piece of writing, on whatever material; e.g. with the stylus on tablets lined with wax, or on a roll of parchment or paper. In modern Latin, a manuscript volume. *Codex rescriptus* or *palimpsestus* is a manuscript consisting of leaves, from which some earlier writing has been erased in order to afford room for the insertion of more recent writing. Many such codices exist; and from the imperfect nature of the erasing process, the earlier writing has in some instances been restored. Considerable fragments of classical works, previously considered as lost, have been thus recovered by Mai from among the contents of the Ambrosian Library at Milan.

Codicil (Lat. codicillus, dim. of codex). In Law, an addition or supplement to a will, for the purpose of altering, explaining, or adding to its contents. Of codicils, as of wills, the latter prevails where it contains provisions contradictory to those of a former. By the recent Wills Act (1 Vict. c. 26), every codicil must be executed in the same manner as is thereby made requisite in the case of a will; viz. signed by the testator in the presence of two witnesses at one time. [WILL.]

Coefficient (Lat. co, and efficio, *I effect*). In Algebra, one of two, simple or compound, factors whose product constitutes a term. Thus in the term $2ab^2c$, $2ab^2$ is the coefficient of c, $2a$ of b^2c and 2 of ab^2c. In the latter case 2 is frequently called the *numerical coefficient* of the term, the others being distinguished as *literal coefficients*. In an algebraical expression, and especially in quantics whose terms involve constant as well as variable factors, it is usual to restrict the term *coefficient* to the former and to refer to the latter as *facients*.

Coefficients, Laplace's. [LAPLACE'S COEFFICIENTS AND FUNCTIONS.]

Coehorn Mortar. A small mortar made of bronze, introduced by the great engineer Coehorn: very portable and useful.

Cœlacanthidæ (Gr. κοῖλος, *hollow*, and ἄκανθα, *a spine*). A family of Ganoid fishes in the system of Agassiz; so called on account of the species composing it being armed with hollow spines. The fossil genera, *Holoptychius* and *Cœlacanthus* proper, belong to this family.

Cœlelmintha (Gr. κοῖλος, and ἕλμινς, *a worm*). The name of a class of Entozoa, including part of the cavitary intestinal worms of Cuvier, or those which are characterised by having an alimentary canal contained in a distinct abdominal cavity.

Cœlenterata (κοῖλος, *concave*, and ἔντερον, *intestine*). A sub-kingdom proposed by some zoologists to include all those animals in which a large internal or 'somatic' cavity is constantly present, and whose body-substance resolves itself into two foundation membranes or layers, one serving the purpose of an integument, the other lining the large internal cavity. It is composed of the two orders *Hydrozoa* and *Actinozoa*, and includes the *Zoophyta*, *Medusidæ*, *Sertularidæ*, Corals, *Actiniæ*, &c. All the *Cœlenterata* are marine, with the exception of two freshwater genera (the *Hydræ* or polyps), and they are generally distributed throughout most seas. Indications of the animals comprised under the term *Cœlenterata* will be found under the heads ACALEPHÆ, ANTHOZOA, and HYDROZOA.

Cœliac (Gr. κοιλία, *the belly*). A painful species of diarrhœa has been by some medical writers called the *cœliac passion*. The *cœliac artery* is the first branch of the aorta in the abdomen.

Cœnaculum (Lat.). In ancient Architecture, the eating or supper room of the Romans. When it became the fashion to dine in the upper rooms, the whole upper story of their houses, which rarely consisted of more than two stories, was often called by this name.

Cœnobio. [CENOBIO.]

Cœnobite or **Cenobite** (Gr. κοινόβιος). One who lives under a rule in a religious community, as distinguished from an anchoret or hermit, who lives in solitude. [ANCHORET.]

Cœnure, Cœnurus (Gr. κοῖνος, and οὐρά, *a tail*). The hydatid which infests the brain of sheep is so called, because the dilated cyst is the common termination or basis of attachment of many heads and bodies. The disease called *staggers* is produced by this parasite.

Coffea (from Caffa, or Kaffa, the name of an Abyssinian province where the tree is found). The genus which contains the Coffee-tree, a member of the great Cinchonaceous order. This plant, the *Coffea arabica*, is a shrub or small tree twenty feet high, with opposite oblong oval leaves, and clusters of small white flowers in their axils, succeeded by red fleshy berries resembling small cherries, each containing two seeds. The coffee shrub is cultivated throughout the tropics, and is the source of considerable trade, upwards of 60,000,000 pounds being in some years imported to this country, of which more than half is retained for home consumption.

Coffee. The berries of the *Coffea arabica*. These, when roasted, powdered, and infused in boiling water, yield the well-known beverage called *coffee*. It is exhilarating, and operates upon many persons as an aperient. [CAFFEIN.]

Coffer (Fr. coffre). In Architecture, this term is applied to the sunk panels in vaults and domes, and also in the soffit, or underside of the Corinthian cornice, usually decorated in the centre with a flower.

Cofferdam. A water-tight case made for the purpose of excluding the water from such work as the wall of a wharf, the pier of a bridge, &c., in order that it may be executed in the dry. A cofferdam is composed of one or more rows of piles, usually of two, between which clay or some impermeable material is

driven; the piles, generally driven close together, are sometimes grooved and tongued, or dovetailed, or if the water be not very deep the piles are driven five or six feet apart and grooved, with boards or plates let into the grooves; but the effectual exclusion of the water is the essential condition of a cofferdam, and great pains must be taken to prevent the passage of water through the joints, and upon the line of junction with the natural soil. The general formula given by Neville (*Civil Engineer Journal*, 1840, iii. 78) is as follows, when there are no stays: $d = \frac{\sqrt{125a^2}}{3.b.s.}$; in which d = the thickness of the dam in clear of piles; c = the depth of water in feet; b = the height of dam in feet; s = the weight of a cubic foot of the dam usually = ninety pounds. (Mosely's *Mechanical Principles of Engineering*, &c.)

Cogs. In Millwork, the term *cogs* is given to the teeth of wheels when they are not of the same piece with the body of the wheel, but are each of a particular piece.

Cognisance. In Heraldry, a crest, coat of arms, or similar badge of distinction, appertaining to a person or family.

Cognisance, Conusance (Lat. cognosco, *I know*). In Law, an acknowledgment of a fine, of taking a distress, &c. It also signifies the power which a court has to hear and determine a particular species of suit.

Cognomen (Lat.). The last of the three names by which all Romans, at least those of good family, were designated, e.g. Publius Virgilius Maro. It served to mark the house [Familia] to which they belonged, as the other two names, viz. the *prænomen* and *nomen*, served respectively to denote the individual and the class [Gens] to which his family belonged.

Cognovit (Lat.). In Law, is a confession whereby a defendant admits that the plaintiff's cause of action against him is just (cognovit actionem), and suffers judgment to be entered against him without trial.

Cogredient. Two sets of facients or variables, each set containing the same number, are said to be *cogredient* if on replacing the variables of the first set by certain linear functions of themselves, those of the second set become also replaced by the *same* linear functions of themselves. Thus the trilinear coordinates x, y, z, and x', y', z', of two points in a plane are cogredient; for if after transformation to new axes the former become replaced respectively by $ax + by + cz$, $a_1x + b_1y + c_1z$, $a_2x + b_2y + c_2z$, the latter will obviously be changed to the same functions of x', y', z'.

Cohesion (Lat. cohæreo, *I hold together*). In Natural Philosophy, is the force or attraction with which the particles of homogeneous bodies are kept attached to each other, or with which they resist separation. Cohesion is thus distinguished from *adhesion*; the latter term denoting the attractive force existing between two different bodies brought into contact, as a drop of water on a plate of glass; or between two bodies of the same matter, as two lumps of lead, when their smooth surfaces have been pressed together. The three different forms which matter assumes—solid, liquid, and gaseous—are determined by the degree of cohesive force existing among the elementary particles. In solids this force is greatest, and, in fact, is that which causes solidity; in liquids it is less powerful, but still sufficiently manifest in the *drops* or globular forms assumed by small quantities of water or mercury poured on a table. In the case of aëriform fluids it may be regarded as negative, the particles having a tendency to repel each other. The cohesive force of the elementary particles of matter depends on the distances of the particles from each other; but of the law according to which its intensity increases or diminishes nothing is known, excepting that the force decreases rapidly as the distance increases, and vanishes altogether when the distance becomes so great as to be appreciable to the senses.

It is a problem of very great importance to determine the cohesive power of the materials employed in mechanical structures. Many experiments have been made for this purpose; and their results have not only a practical utility, but throw much light on the constitution of bodies. When a bar of metal, a beam of wood, or a rope is stretched lengthwise, the tension which it bears, or the cohesive power exerted, is equal to the accumulated attraction of all the particles in any transverse section. The longitudinal distension which takes place before disrupture is at first proportional to this attraction, but afterwards increases in a more rapid progression. 'A bar of soft iron will stretch uniformly by continuing to append to it equal weights till it be loaded with half as much as it can bear; beyond that limit, however, its extension will become doubled by each addition of the eighth part of the disruptive force. Suppose the bar to be an inch square, and 1,000 inches in length; 36,000 lbs. avoirdupois will draw it out one inch, but 45,000 lbs. will stretch it 2 inches, 54,000 lbs. 4 inches, 63,000 lbs. 8 inches, and 72,000 lbs. 16 inches, where it would finally break.' (Leslie's *Natural Philosophy*.)

The following is a tabular view of the absolute cohesion of the principal kinds of timber employed in building and carpentry, showing the load which would rend a prism of an inch square, and the length of the prism which, if suspended, would be torn asunder by its own weight:—

	lbs.	ft.
Teak	12,915	36,049
Oak	11,880	32,900
Sycamore	9,630	35,800
Beech	12,225	38,940
Ash	14,130	42,080
Elm	9,720	39,050
Memel fir	9,540	40,500
Christiania deal	12,346	55,500
Larch	12,240	42,160

The metals differ more widely from each other in their cohesive strength than the several species of wood or vegetable fibres. According to the experiments of Mr. George Rennie in 1817, the cohesive power of a rod an inch square of different metals, in pounds avoirdupois, with the corresponding length in feet, is as follows:—

	lbs.	ft.
Cast steel . . .	134,256	39,455
Swedish malleable iron	72,064	19,749
English ditto . .	55,872	16,938
Cast iron . . .	19,096	6,110
Cast copper . .	19,072	5,003
Yellow brass . .	17,958	5,180
Cast tin . . .	4,736	1,496
Cast lead . . .	1,824	348

Cohobation. The repeated distillation of the same liquid from the same materials. The term was invented by Paracelsus.

Cohort (Lat. cohors). The tenth part of a Roman legion. The *Prætorian cohort* was a body of picked troops who attended the general, and is said to have been first instituted by Scipio Africanus. [Legion.]

Coil of a Gun. Is formed by winding a bar of iron at a welding heat round a mandrel, which is afterwards removed. The rough coil so formed is welded, bored, and turned to the required size. A great part of the Armstrong gun is formed of these coils.

Coins. [Numismatics; Money.]

Coin-weighing Machine. A machine for this purpose, patented by Mr. W. Cotton, was constructed by Mr. Napier for the Bank of England in 1844, and has since been more extensively applied at the Mint.

It consists of a square brass box, on the top of which is placed a hopper to hold the sovereigns to be weighed, and in front of it are two small apertures fitted with receivers, one for the sovereigns of full weight, and the other for light sovereigns. The balance for weighing the sovereigns is placed inside the box near the upper plate, vibrating upon a knife edge, and receiving the sovereigns upon a small platform at one end of the beam and above it. The platform is kept in its place by means of a small pendulum, on which, at about an inch below the platform, there is an oblong perforation, about half an inch in length, technically called a *slot*, in which a small ivory rod works freely up and down, without touching the sides.

Between the slot and the platform a pair of forceps is placed. From a knife-edge at the other end of the beam a small round polished plate is suspended, to which a pendulum is fixed, and at its lower part the scale is placed to receive the weight. Above the small round plate, under the top of the box, is fixed an agate with a blunt point. When the machine is in motion, the small ivory rod is depressed; this, on touching the bottom of the slot, or opening in the pendulum in which it works, brings down the beam on that side, and raises it of course on the other, the weight side, until the small round plate on that side touches the agate point. The beam is then in a horizontal position. As soon as this is effected, the forceps catch hold of the pendulum between the platform and the slot, and hold it firmly. The balance is then in a condition to receive the sovereign, which is shifted from the bottom of the pile in the hopper, and brought by means of a slide along a channel, just large enough for a sovereign of the proper standard gold to pass, but not large enough to admit a counterfeit, and deposited upon the platform. The forceps then let go their hold, the ivory rod is gently raised, and, if the sovereign happens to be light, that end of the beam rises, and the other end leaves the agate point; but, if the sovereign be of full weight, the beam remains stationary, and the small plate on the weight end is in contact with the agate point.

When the sovereign is weighed, the operation of its removal is very ingenious, and is as follows: Two bolts are placed at right angles to each other, and on each side of the platform or scale there is a part cut away to admit of the bolts striking so far into the area of the platform as to remove anything that would nearly fill it. These bolts are made to strike at different elevations, the lower one striking (as to time) a little before the other. If the sovereign be of full weight the scale remains down, and the lower bolt knocks it off into the full-weight box. If the sovereign, on the other hand, be light, it rises up, and the first bolt strikes under and misses it, and the higher bolt then strikes and knocks it off into the light box. The machine weighs about thirty-three sovereigns in one minute. The weights used are of glass, and are adjusted to within the ten-thousandth part of a grain.

The preceding description applies to Mr. Cotton's weighing machines as originally adopted at the Bank of England, for the purpose of detecting light sovereigns. In the year 1852 a series of twelve of these machines, so constructed as to separate blanks, or coins of current weight, from those which are too heavy or too light, and to distribute the pieces thus weighed into three separate boxes, were made by Mr. Napier for the Royal Mint, and are now in constant and successful use. Any detailed description of these more complicated machines would be unintelligible without illustrative plates incompatible with this work. A representation and description of one of them will be found in an article on 'Coining' published in *Tomlinson's Cyclopædia*, 1862.

Coinage. Under this term we shall give a brief outline of the proceedings in reference to the manufacture of coin, as carried on in the Royal Mint of London.

When a parcel of gold is brought to the Mint in ingots, assays are made of each ingot; the importers are then required to attend at the Mint, to receive the assayer's reports, and a Mint bill is given, certifying the weight, fineness, and value of the ingots, and signed by the proper officers, which bill is returned upon the delivery of the bullion to the importers in the state of coin.

The bullion is then delivered to the melter, who, guided by the assayer's report, adds either alloy or fine gold (when either are required), so as to reduce the mass to *standard fineness* (that is 22 parts of pure gold and 2 of alloy), and melts and casts the metal into bars of convenient form for rolling: each bar, when intended for coinage into sovereigns, being an inch and a half by one inch square, and about two feet in length, and weighing about 26 lbs. A piece is then taken from each extremity of each bar and delivered to the assayer, who ascertains that the said bars are of standard fineness before he allows them to be delivered for the purpose of coinage.

These preliminary operations are nearly the same as regards silver bullion.

The bars are then transferred to the Coining Department, where they are rolled and drawn into plates of proper thickness, which require to be most nicely adjusted, so that a piece of proper size punched out of any part of the plate may have the exact weight of the intended coin; the *blanks* are then cut out of these plates, which are thus reduced to the state of *scissel*, and re-melted (under due checks and precautions), to be again cast into bars. The blanks (amounting to about two-thirds, and the scissel to one-third of the weight of the original plate of metal) are next annealed, and passed through the *marking machine*, by which the edge of each piece is made smooth and a little raised; they are then cleaned or *blanched* by being put for a few minutes into a hot and very dilute sulphuric acid, after which they are thoroughly washed and dried, and are ready to be *stamped* or coined. This operation is performed in presses moved by mechanical power, and consists in placing the blanks between two steel dies, upon one of which is engraved the obverse and upon the other the reverse of the coin, so as to give an impression in relief; while the spreading of the piece in a lateral direction is prevented by the rising of a collar at the moment the blow is struck, in which collar is engraved the *milling*, which is thus transferred to the edge of the piece at the same moment that the impressions of the dies are taken upon its two surfaces. The coining presses at the Mint are usually attended by boys, who have only to fill a tube or species of hopper with the blanks; the operation of laying the blank upon the dies, and again throwing it off when stamped, being effected by the machinery connected with the press, thus preventing the risk of crushing the fingers of the persons who used to be employed in this department before these *layers on*, as they are technically called, were adopted. In the coining room at the Mint there are eight presses, each adapted for every species of coin; each press strikes upon an average 60 pieces per minute, or 3,600 per hour; so that in the day's work of 10 hours each press produces about 36,000 pieces; and the eight presses (supposing that they are all in use) stamp 288,000 pieces daily. The money when thus completed is weighed up in what are called *journey weights* for delivery to the importers of the bullion; the gold in 15 lbs. and the silver in 60 lbs. troy. But before any coin is suffered to pass out of the Mint, it is inspected as to its workmanship; and if it be in any respect faulty or imperfect, is rejected for recoinage. The weight and fineness of the money are also ultimately examined and insured by the process of *pixing*, which consists in taking promiscuously from every journey weight of coin a pound in tale, which is carefully weighed by the assay master, who declares aloud the *minus* or *plus* upon each pound (if it be not *standard* or exact), which is recorded by the comptroller and assayer. This determines whether the money has been made within the *remedy* allowed upon the pound troy; but, as the remedy upon the pound is divided among the number of pieces in it, the comptroller weighs several of the pieces individually, and if they are not within the allowed limits, can, in conjunction with the other check officers assembled on this duty, return the coin to the Coining Department, to be remelted and recoined. From the same pound weight of gold or silver the comptroller also takes two pieces, one of which is handed to the chief assay-master to assay, in order to prove that the metal has undergone no deterioration in any of the processes of its manufacture; the other piece is sealed up in a packet and consigned to the *pix box*, which is locked by the separate keys of the check officers, where it remains until the *trial of the pix* by jury before the king or certain of his council, which usually takes place once every three or four years in the Court of Exchequer at Westminster.

The term *journey weight* is applied at the Mint to the weight of certain parcels of coin, which were probably considered formerly as a day's work. The journey of gold is 15 troy pounds, which is coined into 701 sovereigns, or 1,402 half-sovereigns. A journey of silver weighs 60 lbs. troy, and is coined into 792 crowns, or 1,584 half-crowns, or 1,980 florins, or 3,960 shillings, or 7,920 sixpences.

Coke. The charcoal obtained by heating coal with the imperfect access of air, or by its distillation. The former is usually called *oven coke*; the latter *gas coke*, being abundantly produced in gas-works. The weight of coke usually amounts to between 60 and 70 per cent. of the coal employed. Coke is a valuable fuel for many purposes in the arts.

Coking Coal. Those kinds of Bituminous Coal which it is necessary to convert into coke before they can be advantageously used in furnaces, in consequence of their caking in the fire. Most of the coal of Northumberland and Durham is of this quality. [CAKING COAL.]

Cola (Kola, the native African name). A small genus of *Sterculiaceæ* inhabiting Western Tropical Africa. The fruit consists of two, sometimes more, separate pods (follicles), containing several seeds about the size of horse-chestnuts. Those of *C. acuminata* are called Kolla, Cola, or Goora nuts, and are extensively used as a condiment by the African natives, as well as by the negroes of the West Indies and

Brazil, where the tree has been introduced. They are said to render half-putrid water drinkable. A considerable trade is carried on in Cola-nuts by the natives in the interior of Africa, the trees growing mostly near the coast.

Colchicine. An alkaloid obtained from, and probably constituting the active principle of the *Colchicum autumnale*. It was formerly confounded with *Veratrine*.

Colchicum (from Colchis in Armenia, where the plant is said to have abounded). This term is generally applied to the corm or bulb of the *Colchicum autumnale*, or Meadow Saffron, a plant common in this country, and largely collected for medical use. *Colchicum* belongs to the order *Melanthaceæ*, and bears crocus-like flowers in autumn, followed in spring by shining sword-shaped leaves. It was much employed formerly as a diuretic in dropsy; it then fell into disuse, but it has been recently again largely prescribed for the cure of gout, the fact having been ascertained that the celebrated French remedy for gout called *Eau médicinale d'Husson* was a tincture of colchicum. When the corms are intended for medical use, they should be dug up in summer (July), and immediately cut into thin transverse slices, placed separately upon paper, and dried by a very gentle heat. The best preparation is the *wine of colchicum*, made by infusing an ounce and a half of the bulb prepared and dried as above, and coarsely powdered, in twelve ounces of sherry, for six or seven days, shaking it daily: then filter it for use. The dose is from 20 drops to 1 drachm, taken at bed-time in a little water. The *seeds* of colchicum are also officinal, and are, by some, preferred to the corms.

Colcothar. A red oxide of iron, being the residue of the distillation of green vitriol or sulphate of iron.

Cold Blast. The air forced through furnaces used for smelting iron at its natural temperature, is called a *cold blast*, in opposition to the *air blasts*, which are heated by artificial means. The cast iron obtained by the cold blast is tougher and stronger than the hot-blast iron; it presents a closer texture and a smaller crystallisation than the latter; the specific gravity of cold-blast iron is less than that of the hot blast, and its modulus of elasticity appears also to be less.

Cold-blooded. In Zoology, those animals are so called which have a range of temperature from a little above the freezing-point to 90° Fahr. and upwards, and which follow the changes of the surrounding medium through that range. Almost all invertebrate animals, and fishes and reptiles amongst vertebrates, are *cold-blooded* in this sense.

Coleophyllum (Gr. κολεός, *a sheath*, and φύλλον, *a leaf*). A term introduced into Botany, to indicate a monocotyledonous structure, the young leaves being evolved from within a sheath, while those of Dicotyledons are always naked.

Coleopterans (Gr. κολεόπτερα, *sheath-winged*). The name of the order of insects comprehending those in which the first pair of wings have the consistence of horn, and serve as defensive coverings to the second pair, or true wings, which are of large size, and are folded transversely when not in use.

By means of this mechanism the *Coleoptera* are enabled to burrow in the soil, or bore the trunks of trees, without injury to their delicate organs of flight, which are the true or second pair of wings. These, being of ample size, are peculiarly folded, being bent at nearly right angles, so as to pack up in small compass beneath the elytra or wing-covers, when the beetle is at rest. In some species the membranous wings are wanting, but the elytra are always present; although in this case, as they are never required to be expanded for flight, they are generally soldered together by a straight suture at the middle line. In ordinary cases the inner straight margins of the wing-covers are simply but accurately applied to each other.

The *Coleopterans* are of all the orders of insects the most numerous, and the best known. Their singular forms, the brilliant and agreeable colours which many of them present, the large size of some of the species, the solid consistence of their teguments, which renders their preservation easy, and the regular series of affinities traceable through several of the groups, all combine to render them objects of particular interest and attention.

The head supports two antennæ of various forms, but almost always consisting of eleven joints. They have two compound eyes, but no ocelli. The mouth is composed of six principal pieces; of which four, called the mandibulæ and maxillæ, move transversely in pairs, while the remaining two are fixed, and close the mouth vertically. The uppermost of the two vertical pieces is called the *labrum*; the lowermost is termed the *labium*, and is itself subdivided into the *mentum* and *lingua*, and together with the maxillæ, or the lowest of the vertical pieces, supports a pair of articulated processes, called *palpi* or *feelers*.

The anterior segment of the thorax, or manitrunk, supports the first pair of feet, and greatly surpasses in extent the two other segments which form the alitrunk. The abdomen is sessile, and united to the trunk by a great part of its breadth. It is externally composed of six or seven wings.

The *tarsi* vary as to the number of their joints, in some *Coleoptera* having but three, in others four, in others five—modifications upon which Latreille founds his primary division of the order, Pentamera, Tetramera, Trimera.

The *Coleoptera* undergo a complete metamorphosis. The larva resembles a worm; the head is encased in a firm horny substance; the mouth is analogous in the number and functions of its parts to that of the perfect insects; it has also generally six feet, but some species have instead only simple tubercles. When perfect the larva generally burrows in the

earth, and excavates an oval cell, within which it undergoes its change into an inactive pupa; this is generally of a whitish colour, with the wings and legs folded upon the breast. The habitation and manner of life of these insects vary much, both in their immature and perfect stages. The affinities of the *Coleoptera* to the *Orthoptera* are of a closer and more manifest nature than can be traced between the *Coleoptera* and any other order of the mandibulate insects. The genus *Forficula* forms the intervening link. It was formerly placed by Linnæus at the end of the *Coleoptera*, and was subsequently referred by Latreille to the order *Orthoptera*; but now constitutes the type of an order apart and intermediate to these two. The absence in some ants of the wings, sting, and ocelli, has led Mr. Macleay to suspect that these *Hymenoptera* make an approach to the *Coleoptera*. Mr. Kirby would place the *Strepsiptera* in juxtaposition with the *Coleoptera*, observing that the metamorphosis in the former 'being different from that of *Orthoptera* and *Hemiptera*, and nearer to that of the *Coleoptera*, this seems its most natural station, considered as an Elytrophorous order.'

Coleoptilum (Gr. κολεός, and πτίλον, *a feather*). A term sometimes applied to the young leaves of Monocotyledons, from the circumstance of their always being developed within a sheath.

Coleorhiza (Gr. κολεός, and ῥίζα, *a root*). A term invented by Mirbel to denote the sheath within which the radicle of monocotyledonous plants is enclosed.

Colic (Gr. κωλικός, from κῶλον, *the colon*; one of the large intestines, the seat to which the principal pain is generally referred). There are many varieties of this complaint, and it arises from various causes, and exhibits different symptoms. The general indications of cure are to evacuate the bowels by the least irritating means, and, when the lower intestines are loaded, by the use of glysters; opiates and etherial remedies may be resorted to to allay spasms, and warm bath and fomentations are often necessary.

There is a peculiar disease called the *painter's colic* or *dry bellyache*, which appears to arise from the absorption of lead into the system, and which therefore commonly attacks plumbers, painters, and makers of white paint and other colours and preparations in which lead is used; the persons employed in the lead mines and furnaces are also subject to it. It is often named from certain places in which it is peculiarly prevalent; as Poitou, Devonshire colic, &c. It begins with restlessness and uneasiness about the stomach, nausea, and obstinate costiveness. There is general spasm of the bowels, often accompanied by great pain, which is somewhat relieved by pressure; and this circumstance enables us to distinguish the complaint in question from inflammation of the bowels; into which, however, it runs, if not relieved by opiates, emollient glysters, warm bath, and gentle aperients, especially castor oil when it will remain on the stomach, by which the spasm is allayed and the bowels evacuated of their hardened and irritating fæces. This is the *acute* state of the disease; but it often occurs in a *chronic* form, in which case pains and constipation of the bowels are followed by occasional delirium, epilepsy, paralysis, especially of the hands, and wasting away of the muscles. This disease often terminates fatally. The patient should always be cautiously removed from all contact with lead, and allowed fresh air and a nutritious but not stimulating diet.

Coliseum. [AMPHITHEATRE.]

Collapse (Lat. collapsus, part. of collabor, *I shrink down*). A wasting of the body; or a sudden and extreme depression of its strength and energies.

Collar (Lat. collum, *the neck*). A peculiar badge worn round the neck by knights of different orders. It consists of a gold chain, enamelled, &c., to which is attached the badge of the order of knighthood; and it is worn at court chiefly on state occasions, which are thence called *collar days*.

COLLAR. In Architecture, a horizontal piece of timber connecting two rafters.

COLLAR. In Malacology, the thickened secreting margin of the mantle in the testaceous Gastropods.

COLLAR. In Ornithology, the coloured ring round the neck of birds.

Collar-beam. A piece of timber connecting opposite principal rafters, or the small rafters of a roof, and placed above the level of the feet of the rafters. The name is also generally given to the straining piece of a queen post truss.

Collateral Circulation. In Physiology, the passage of the blood from one part to another of the same system of vessels by collateral communicating channels; it is much more frequent in the veins than in the arteries.

Collect. A term, of doubtful derivation, applied to certain short prayers found in the liturgies of all churches. (Hook's *Church Dictionary*.)

Collectanea (Lat.). A term applied, in Literature, to a selection of passages made from various authors, usually for the purpose of instruction.

Collectors. In Botany, dense hairs covering the styles of some species of *Compositæ*, &c., and acting as brushes to clear the pollen out of the cells of the anthers.

College (Lat. collegium). According to the primary meaning of the word, any society or number of persons bound together by the same laws or customs (*Collegæ*, *colleagues*). Among the Romans, not only societies invested with a character resembling that of modern corporations, enjoying certain political rights in common (as the colleges of augurs, pontifices, &c.), were termed *collegia*; but bodies of men who appear to have had no bond of union except common employment (as the collegia opificum, or colleges of the different trades) were also thus

designated. Hence has originated the erroneous notion that the guilds of modern Europe were derived from similar institutions among the ancients, by attributing to the last-mentioned collegia a corporate character, which it is not sufficiently proved that they possessed; although some of these bodies, as we learn from the fragments of the lawyer Gaius, did in effect hold common property, and had their affairs administered by by-laws of their own. In England many corporate bodies are termed *colleges*; e.g. the colleges of physicians and surgeons, of heralds, &c. &c. A college, in the academical meaning of the word, signifies a society established for academic purposes under royal or private foundation, endowed with revenues, and subject to a private code of laws. Where such a society possesses within itself all the means of instruction and the rights and faculties which are incident to a university, the terms *university* and *college* are among ourselves convertible, and indiscriminately used. Thus, Trinity College, Dublin, affords a specimen of an institution called indiscriminately by either title. On the other hand, the universities of Oxford and Cambridge are composed of a number of colleges united together under the same discipline and government, and in which those powers peculiarly belonging to a university are wielded by one class of authorities, the functions of the colleges being superintended by another. The Scottish universities, not being in the strict sense of the words endowed societies (i.e. not possessing a regular body of fellows and scholars receiving stipends), cannot be properly termed collegiate bodies.

The early history of colleges is somewhat obscure; although there can be no doubt that they were originally founded, in the various universities of the middle ages, with similar objects and from the same charitable motives. The first students at these universities assembled together under no common bond of union, except that of academic study and discipline, and lodged as suited their own convenience. Next, hostels or boarding-houses were established (in the first instance, it is said, by the religious orders for students of their own fraternities), in which the scholars lodged together under certain superintendence. Charitable individuals afterwards endowed these hostels, for the purpose of providing poor scholars with free lodgings. Finally, to these endowments were added (by gifts or bequests) stipends for all or a certain number of the scholars frequenting these inns or hostels; and thus the foundation of a college was completed. The distinction of language arising from ancient usages is still preserved at Oxford, where societies endowed for the maintenance of fellows and scholars are termed *colleges*; societies unprovided with such endowments, *halls*. But at Cambridge there is no distinction between *colleges* and *halls*. At the university of Paris fifteen colleges, or more, are said to have been founded in the thirteenth century; and the whole number, in the course of time, amounted to eighteen greater and about eighty lesser. But these institutions assumed a different shape from that which they took in England. The greater colleges became appropriated to particular faculties, or departments of a faculty. Thus, for example, the Sorbonne was the college of the theological faculty; and, in process of time, the lectures and disputations of most of the faculties became confined to the walls of those colleges which were exclusively devoted to them. Hence the university became, in fact, a collection of academies for instruction in particular subjects, and its corporate character for purposes of education vanished altogether as early as the fifteenth century; and the word *college*, in France, has now come to signify, in popular language, the higher order of schools. (See Malden, *On the Origin of Universities*, and the authorities there cited.)

The name and institution of colleges were derived by the English universities, together with most of their other peculiarities, from Paris; but their history is very different. The colleges now subsisting in the English universities were constituted by royal or private munificence; either as original foundations, or (more commonly) by the endowment of formerly subsisting halls or hostels with stipends for students. They were all formed on the same principle, consisting of a head (variously termed *master*, *principal*, *provost*, &c.) and of a body of fellows and scholars. The colleges were thus founded simply for the purpose of assisting scholars in their progress through the university, not for that of conferring instruction. All those of Catholic foundation, it must be added, were intended to supply the church with ministers; hence the still subsisting or but recently modified regulations prohibiting the marriage of fellows. In the course of time independent members, i.e. members not upon the foundation nor sharing in the endowments, were admitted to reside within the walls of the colleges; and the task of superintending, and finally of instructing them, was gradually transferred from the university authorities to those appointed by and resident within the colleges. By the present constitution of the two English universities, the only powers retained by the university as such are of a general character, as of conferring degrees and other honours, &c. &c.; while the function of education for the purpose of qualifying for those degrees has entirely passed into the hands of the colleges of which the entire body is composed, every member of the university being now, by usage which has acquired the force of law, also member of some college or hall. With respect to discipline and government, the power is shared between the university, which through its vice-chancellor and proctors exercises a general superintendence, and the colleges, which by their own officers maintain order within their own walls. A college, therefore, in the sense in which the term is applied at Oxford and Cambridge, has a double character—1. As an endowed society.

2. As a house of education. In the first sense, the college is composed of the head, fellows, and scholars. It is under the government of the original laws framed by its founder, with such variations as in some cases time has introduced; but alteration is always jealously watched. According to the tenure of these statutes, the head is either chosen by the fellows from among themselves, or in some instances appointed by the crown or other authority. The fellows, again (who are mostly, but not universally, graduates who have passed the lowest degree, that of Bachelor of Arts), and the scholars, who are admitted when undergraduates, are either chosen from particular localities, schools, &c. &c., according to the will of the founder, or elected according to merit after free competition between members of the college or of the university at large. Every college is finally under the superintendence of a visitor, generally some high ecclesiastical functionary. 2. As a place of education, the college receives within its walls not only fellows and scholars, but also (in the great majority of instances) independent members, limited in number only by the extent of the lodging which it can afford; it being usual at Oxford (although not at Cambridge) that every student on entering the university should not only belong to a college or hall, but reside within its walls. The undergraduate members of the college are under the superintendence of the tutors. These are, in general, resident fellows, appointed by the head to perform this office. In some colleges each tutor has under his special control a certain number of undergraduates; in others the tutors divide among them, not the students, but the different branches of instruction which are to be communicated. Such is a very general outline of the system of English colleges; but each of these foundations is exclusively governed by its own laws and usages, and no comprehensive description will apply without exception to all. Oxford has nineteen colleges and five halls; Cambridge seventeen colleges or halls. In both universities the oldest are supposed to have existed from the middle of the thirteenth century; the greater part were founded between that period and the Reformation, but a few are of Protestant foundation. [UNIVERSITY.]

College of Justice. In Scottish Law, a term applied to the supreme civil courts, composed of the lords of council and session; together with the advocates, clerks of session, clerks of the bills, writers to the signet, &c. [SESSION.]

Collegiate Church. In English Ecclesiastical Law, a church, not a cathedral, having an endowment for a society or body corporate consisting of a dean and chapter.

Collet. [COLLUM.]

Collidine. An organic base found in bone-oil.

Collimation (Lat. collimo, *I aim at*). The *line* of collimation, in a telescope, is the line of sight, or the straight line which passes through the centre of the object-glass and the intersection of the wires placed in its focus. The *error* of collimation is the difference between the actual line of sight and the position which that line ought to have in reference to the instrument.

Collimator. A fixed telescope with a system of wires at its focus. If the cross-wires of the collimator bo illuminated, the rays from them will issue parallel, and consequently be in a fit state to be brought to a focus by the object-glass of any other telescope, in which they will form an image as if they came from a celestial object. Hence the intersection of the cross-wires of the collimator may be used as a standard point of reference, always visible, and the least change in the position of a movable instrument in any direction observed. In large observatories the transit collimators are arranged opposite each other, so that when the large telescope is raised, the image of the cross-wires of the other is viewed superposed, or nearly so, on the system proper to each: when the large telescope is in position, it can look into both. By these means, in a reversible instrument, all errors or changes of position may be detected.

Captain Kater's floating collimator consists of a telescope kept either in a horizontal or vertical position by resting on a float in mercury. This arrangement for fixing the zenith and nadir points is now, however, superseded by reflection from the surface of mercury. We may also add that a recent addition to the transit, devised by Mr. Cook of York, which consists in fixing levels of extreme delicacy to the telescope, bids fair in time to supersede the use of collimators to a very great extent. (Pearson's *Practical Astronomy*, vol. ii.)

Collinear (Lat. con, and linea, *a line*). Two figures, or systems of points, are said to be *collinear*, when the relation between them is such that to any point in either system corresponds but one point in the other, whilst to the several points of a right line in either system correspond those of a right line in the other system. In establishing such a relation between two *plane* figures, four pairs of corresponding points may be chosen arbitrarily; this being done, however, all other pairs are defined. It is always possible to give the planes of two collinear figures such a position, that the one figure shall be the projection of the other with respect to some centre of projection in space. The term *collinear* appears to have originated with Möbius, in whose *Barycentric Calculus* the nature of this relation is thoroughly examined. It includes the relations of *affinity* and *similarity*, and is identical with the *homographic* relation, as originally defined by Chasles (*Géométrie Supérieure*).

Colliquative (Lat. colliquesco, *I melt*). Excessive evacuations are so termed, which appear to melt down the strength and substance of the body.

Collision (Lat. collido, *I strike against*). In Mechanics, the impact of two bodies, one or

both of which were previously in motion. The laws of the direct impact of two spherical bodies are deduced from the principle that the sum of the momenta of the impinging bodies, estimated in a fixed direction along the line of motion, is not altered by the collision. The velocities of the bodies after impact, however, depend upon the hardness and elasticity of these bodies. If perfectly hard, they will move, after impact, as one body with a velocity, and in a direction, which is ascertained by dividing the algebraical sum of their previous momenta by that of their masses. If not perfectly hard, a certain compression takes place on collision, and is immediately followed by a more or less perfect restitution of form, according to the degrees of elasticity which the bodies possess. In the case of perfectly elastic bodies this force of restitution is equal to that of compression, and the loss or gain in the velocity of each body which occurred at the moment of collision or commencement of compression, at which moment the bodies may still be regarded as perfectly hard, is precisely repeated. Thus if m and m denote the masses of two bodies whose velocities v and v_1 are considered as positive or negative according to the direction of the motion, then in the case of perfect hardness the common velocity after impact would be $V = \frac{mv + m_1 v_1}{m + m_1}$; $V - v$ and $V - v_1$, therefore, are the increments in velocity which, in perfectly elastic bodies, are repeated so as to produce the final velocities $2V - v$ and $2V - v_1$ respectively. In the case of imperfectly elastic bodies, the final velocities would be $V + e(V - v)$ and $V + e(V - v_1)$, where the constant *proper fraction* e depends upon the elasticity of the bodies, and must be ascertained by experiment.

In all cases of collision the state of the centre of gravity, whether at rest or in motion, remains the same after the impact as it was before. If it was at rest, it remains in that state; and if it was in motion, it continues to move in the same direction with the same velocity, notwithstanding the impact. This is the case both in respect of non-elastic and elastic bodies; and it is a constant law in whatever manner the bodies act on each other, and whatever be their respective natures.

All good text-books on mechanics treat the problem of the collision of bodies at considerable length; we must refer the reader to them for particulars concerning oblique impact, where the common normal to the impinging bodies at their point of impact no longer coincides with the line of motion.

Collodion (Gr. κόλλα, *glue*). A term applied, in consequence of its adhesive properties, to a solution of gun-cotton in ether. It is now largely used by photographic artists.

Colloids. When a solution of common salt in water is placed at the bottom of a jar, pure water poured gradually over it so as not to be mechanically mixed with the salt solution, and the whole set aside, diffusion of the salt up into the water commences at once and proceeds with a certain rapidity. But if white of egg instead of solution of salt be employed, an equal amount of diffusion will require a period fifty times longer than that occupied by the salt. Gelatine is another substance which diffuses into water so slowly that the purest form of it, which is termed *collin*, is taken as the type of all similar substances, which are hence called *colloids*. Crystalline bodies diffuse with greatest rapidity; hence substances which are not colloids are known as *crystalloids*.

Colloids are highly susceptible of change. It is, therefore, not surprising to find that the organic proximate principles of food, substances that obviously must admit of easy assimilation, are colloids. Under certain conditions, also, silica, alumina, and peroxide of iron are colloids. Other facts concerning this class of bodies will be found under DIALYSIS.

Collum (Lat. *the neck*). That part of the axis of a plant whence the stem and root diverge. In the beginning it is a space which there is no difficulty in distinguishing, so long as the embryo or young plant has not undergone any considerable change; but in the process of time it is externally obliterated, so as to become a mere matter of theory.

Collutorium (a word coined from Lat. colluo, *I wash*, and os, *the mouth*). A lotion for rinsing the mouth.

Collyridians (Gr. κολλυρίς, *a roll of bread*). A sect of the fourth century found in Thrace and Arabia, so called from their offering little cakes in honour of the Virgin Mary.

Collyrite (Gr. κόλλα, *glue*; from its gelatinous appearance). A hydrated disilicate of alumina. It is found at Ezquerra in the Pyrenees, near Schemnitz in Hungary, and in porphyry at Wissenfels in Saxony. A variety is also found in agglomerated masses, often stained red externally with oxide of iron; porous and easily friable, filling fissures in an old pit in the Upper Chalk, at Hove, near Brighton. The name Hovite has been proposed for this variety.

Collyrium (Gr. κολλύριον). Lotions intended to check inordinate discharges. The term is now exclusively applied to *eye-waters*.

Coloboma (Gr. κολοβόω, *I shorten*). The adhesion of the eyelids. Congenital fissures of the upper eyelid.

Colobus (Gr. κολοβός, *mutilated*). A genus of long-tailed Quadrumanes, or monkeys; so called, because the fore hands are deficient in, and, as it were, mutilated of, a thumb. In this respect the *Colobi*, which are exclusively limited to the African continent, resemble the spider-monkeys (*Ateles*) of South America; but they have not a prehensile tail to compensate for the imperfection of the hands; their long caudal appendage is, on the contrary, terminated by a tuft of hairs. The *Colobi* differ also from the *Ateles* in having five molar teeth instead of six on each side of each jaw, and in having cheek-pouches.

Colocynth (Lat. colocynthis, Gr. κολοκυνθίς). This term is applied in the Materia

Medica to the pith of the Bitter Apple, the fruit of the *Citrullus Colocynthis*, which is violently purgative. It is imported dried, and generally peeled, from Turkey, and is rarely used alone. One of the most valuable purgatives is the *compound extract of colocynth*, which is a combination of this drug with aloes, scammony, cardamom seeds, and soap.

Cologne Earth. A deep brown pigment, or species of Umber; supposed to be of vegetable origin.

Colombin. The neutral active principle of Calumba Root.

Colon (Gr.). This name is given to the greater part of the large intestines: the colon passes upwards towards the liver, forming the *transverse arch* which descends upon the left side, and forms its *sigmoid flexure*; entering the pelvis, it passes into the *rectum*.

Colon. In Grammar. [Punctuation.]

Colonel (a word of doubtful origin). The responsible command of every battalion of a regiment of infantry and every regiment of cavalry is vested in a lieutenant-colonel. Every lieutenant-colonel after five years in command becomes a colonel. This makes no difference in his regimental position; but all the colonels in the army in order of seniority become general officers. Every regiment has a colonel who is a general officer, and whose command is honorary only. These colonelcies are given to distinguished and meritorious officers, and princes of the blood-royal.

Colonnade (Fr. from Lat. columna). A range of columns attached to, or detached from, the body of the building they are introduced to ornament. When surrounding the building on the exterior, the colonnade is called a *peristyle*; when detached from the general line and projecting forward, it is called a *portico*; but when comprised under the same cornice as the building itself, as at the Louvre, it is called a *colonnade*.

Colony (Lat. colonia). Colonies are establishments formed in foreign countries by bodies of men who voluntarily emigrate from, or are forcibly sent abroad by, their mother country. Various motives have, at different periods, led to the formation of colonies. Sometimes, as in the case of most part of the ancient Greek colonies, they were formed by citizens driven from their native country by the violence of political factions; sometimes, as in the case of the Roman colonies, they were formed for the purpose of bridling subjugated provinces: the latter, indeed, were a species of camps or military stations, forming, as it were, the advanced posts of that mighty army which had its head-quarters at Rome. Sometimes, again, as in the case of the Phœnician colonies, and of most of those established in modern times, they have been formed for commercial purposes, or in the view of enriching the mother country, by opening new markets from which she might, if she chose, exclude foreigners. Most of the Greek colonies being founded by private adventurers, who received no assistance from the government of the parent state, were really independent; the duty which they owed to their metropolis being such only as is due to kinsmen and friends, and not that due by subjects to their rulers. The Roman colonies, on the other hand, being founded by the state for an important political purpose, were always dependent upon Rome. They formed the great bulwarks of the empire. Nor was the conquest of any province ever supposed to be completed till colonies had been established in it, and roads had rendered it accessible to the legions. The colonies established for commercial purposes have generally been subjected to such regulations as were deemed most for the advantage of the parent state. Their growth has thus in many instances been retarded; and they have been rendered less serviceable to their founders than they would have been had they been treated with greater liberality.

The very narrow limits within which this article must be compressed make it necessary that we should confine our statements to such remarks as have a more particular reference to those questions of colonial policy which are most interesting to the English reader.

The advantages supposed to result from that monopoly of a colonial trade which all modern countries possessed of dependencies have endeavoured to enforce, seem to be altogether imaginary. The ties of kindred, and the identity of language, customs, and manners, give the merchants of the mother country great advantages, and enable them, provided their goods be about as cheap as those of others, to supply the colonial markets in preference to everyone else. But all attempts to establish a monopoly in favour of the mother country, by prohibiting the importation of the produce of other nations into the colony, are necessarily either useless or prejudicial, not merely to its interests, but even to those of the mother country. If the latter can produce the articles required by the colony as cheap or cheaper than others, she will command the supply of the colonial markets, without any interference whatever; and if she cannot do this, unless by excluding the cheaper products of others, then it is plain that the goods sent to the colony can only be produced by diverting a portion of the capital and industry of the mother country into comparatively disadvantageous channels, or into businesses in which she is excelled by others: it is plain, too, that no artificial monopolies can be maintained, except in the case of small and easily guarded colonies. The British merchants have at present the supply of by far the greater part of the manufactured goods required by our North American possessions; because the goods they send to them are generally cheaper than those sent there by other parties. But were competitors capable of underselling our merchants to appear in the field, they would have very little difficulty indeed in depriving them of these markets. Cheap goods are sure to make their way through every barrier; and

the frontier of our North American colonies is so very extensive, and the impossibility of guarding it so obvious, that the smallest saving in point of expense would occasion the clandestine introduction of prohibited goods in unlimited quantities. In such a case custom-house enactments are good for nothing. All the tyrannical regulations and sanguinary punishments of Spain and Portugal were unable to prevent their transatlantic possessions being deluged with the prohibited commodities of Britain, France, and Germany. The ability to supply it with comparatively cheap goods is the only means by which it is possible to preserve any market. It is this that secures for us at this moment the same superiority in the markets of the United States that we possessed in them when they were our dependencies; and the moment we lose this advantage we shall not merely lose their market, but, with it, the markets of *all* our colonies. Nothing, therefore, can in reality be more futile than to found colonies, or to retain them in a state of unwilling dependence, with the view of monopolising their trade. If we can undersell others, we shall command their markets without any sort of interference; and if we cannot do this, the attempt to force upon them comparatively dear goods is sure to be defeated; or if, unhappily, it should have a partial success, it would be injurious alike to the mother country and the colony.

A colony might be advantageous, and might contribute to increase the wealth of the mother country, if it yielded a greater revenue than was required for its government and defence; but this is rarely the case. Most colonies require a heavy outlay on their first foundation; and when they attain to any considerable importance, all attempts to make them contribute directly to increase the income of the mother country are very apt to excite discontent, and probably even rebellion: an unfortunate attempt of this sort led, in fact, to the American war. To obviate all chance of any such disastrous event occurring in future, we have distinctly renounced all pretensions to make our colonies contribute anything, unless it be towards defraying the expense of their local government and militia.

If a colony enjoy a natural monopoly of any product or article in extensive demand, it is supposed that, by laying a heavy duty on its exportation, a considerable advantage may be made to accrue to the mother country; but this, though sometimes, is but seldom the case. The monopoly of the opium of India affords one of the most striking instances of revenue thus obtained. Being produced more cheaply in Hindustan than anywhere else, government is able, by monopolising its culture, or rather by obliging it when produced to be sold to them at a certain price, and then selling it for exportation at a much higher price, to realise a large revenue. And it would do the same, and perhaps with better effect, if, supposing it could prevent a smuggling export trade, it left production to take its own course, and merely taxed it when exported. The opium produced in India is mostly all sent to China, where the consumption now (1863) amounts to above 70,000 chests a year, producing a nett annual revenue of above 4,000,000*l.* sterling.

But a revenue arising from a source of this kind requires to be managed with great discretion. The duty imposed on the taxed article must never be so high as to equalise the peculiar advantages possessed by the colonists for its production, or greatly to narrow the demand for it in foreign countries. By neglecting these indispensable conditions the Dutch ruined the trade in spices from Amboyna and the Spice Islands, and we nearly destroyed the trade in cinnamon from Ceylon. The last-mentioned article might have borne an export duty of 3*d.* or 4*d.* per pound; but being loaded with an exorbitant duty of 3*s.* per pound, its exportation all but ceased, and could only be revived by the total abolition of the duty.

When a nation derives the whole or any considerable portion of any important article from abroad, it is necessarily exposed, especially when the supply comes from one or a few foreign countries, to the risk of more or less inconvenience, from an interruption of the friendly intercourse subsisting with such countries. When such important articles are furnished by a colony, their supply is said to be comparatively secure; and, in such cases, colonial possessions are supposed to be very valuable.

The cessation of the supplies of cotton has been quoted as a case in point, and it has been said that it could not have occurred had they been derived from one of our colonial possessions. But the disruption of the American Union, and the prolonged contest by which it has been followed, are events that were less probable than the assertion of colonial independence. The truth is, that the continued dependence of none, save comparatively small or unimportant colonies, can be safely reckoned upon. The independence of all great colonies is sooner or later sure to take place; and even during the period of their dependence on the mother country, so changed are the relations which now subsist between both parties, that no direct action could be brought to bear on the colony with a view towards specifying and determining particular branches of industry or production, without provoking active opposition.

In effect, a colony looked on as a source for raw materials, or as a market for manufactured goods, stands on the same footing as any foreign state, in the former case absolutely, in the latter almost equally so, except in so far as the habits and tastes of the colonists induce them to prefer the manufactures of the country in which they were born or brought up, to those with which they are less familiar. It will be seen, however, in the gradual and certain assimilation of civilised communities, that no preference can be maintained in the colonial

market, except on the ground of comparative cheapness and efficiency.

It was long supposed that our colonies in the West Indies were peculiarly valuable from their furnishing us with a secure and abundant supply of sugar, an article now become a necessary of life, and yielding a very large revenue. We doubt, however, whether there was ever any good foundation for such an opinion; but, whatever may have been the case formerly, there is none now. Sugar is not produced in one or a few countries only; but is a staple product of almost all intertropical regions; and it is now largely produced even in the northern parts of Europe. [SUGAR.] So far, indeed, is it from being true that we are indebted to our West Indian colonies for abundant supplies of sugar, that of 9,180,980 cwt. sugar retained for home consumption in 1861, the West Indies only supplied us with 3,695,149 cwt. The residue was supplied by the Mauritius and India, and by Cuba, Java, and other foreign dependencies. So vast is the field whence supplies of sugar are now derived, that the total cessation of those from the West Indies would have a severe, but perhaps only a temporary, effect on prices.

Great stress is frequently laid on the advantage of colonies established in unoccupied countries, as affording a field for the ready and beneficial employment of the surplus or unemployed population that occasionally abounds in old settled and densely peopled countries; neither can there be a doubt that this is of very material importance. But, the settlement once fairly started, the outfall of emigration is determined by economical stimulants, and not at all by political connection. Labour, in such colonies, is always in great demand, and a regard for their own interests always disposes the colonists to give every fair facility to the immigration of labourers. Notwithstanding the advantages occasionally held out by the British government to encourage emigration to our North American colonies, the great current of emigration has always been directed to the United States; and, even of the emigrants that sail from this country for Canada, scarcely a fourth part remain in the province, but immediately leave it for the contiguous states of the Union. It is idle, therefore, to excuse the policy of attempting to retain colonies in a state of dependence on the mother country, on pretence of their affording, by virtue of this dependence, a readier outlet for poor or unemployed persons. The interest of the settlers will keep this outlet open, and will secure every real advantage that could, in this respect, be derived from the most complete imperial supervision.

It must not, however, be supposed, from anything now stated, that we regard the foundation of colonies as inexpedient; or that colonisation should be discouraged. We may as well talk of discouraging a law of nature. The real questions are, first, What should be the relation between a colony and the mother country? second, How long should that relation continue? The first question, as has been stated, has long since been settled, our own government having abandoned all right or authority over such colonies or dependencies as are not military conquests or military outposts, and having left the settlers to manage their internal affairs at their own discretion. So complete is this self-government, that we have not interposed the veto of the crown on the revival of those Protectionist principles in our colonies which we have long since abandoned at home, even though the regulations of some colonial tariffs, those for instance of Canada and Australia, have appeared to be directed towards the universal chimæra of Protectionist theories, the greater developement of domestic industry.

But the second question—one which never would have arisen but from the absolute settlement of the first—is of greater importance and keener debate. Shall we throw off a colony against its will, or before it demands independence? Which of the two parties, the mother country or the colony, is to be first consulted as to the period at which the connection is to be severed? Assuming that the advantage of dependence is wholly on the side of the colony, or is supposed to be so, what is the process by which the ultimate detachment of the colony should be effected? How shall the support be gradually withdrawn so as to accustom the colony to all those liabilities of political action which should go along with the privileges of political independence? These questions, discussed at present with no little warmth and acrimony, cannot be entered into within the limits of the present article, and the reader is referred to Mr. Merivale's work on Colonisation, and Professor Goldwin Smith's letters on 'The Empire,' for further details.

We have indeed abandoned the idea of keeping settlements in a state of pupilage, of directing their affairs from a colonial office in the mother country, and of regulating their markets with a view to the fancied advantages of a monopoly of sale. We found out that no economical benefit was derived from the system; and the political evils were manifest. For the government of a dependency by the chief of a bureau had all the disadvantages which could arise from the exercise of authority almost arbitrary. Even in a constitutional and responsible government such as that which we enjoy, the ordinary course of parliamentary supervision was not, and could not be, any efficient check to maladministration, simply because parliament can with difficulty be moved to take effectual cognisance of colonial affairs.

At the same time, it must be admitted that, even in the bygone days of the colonial theory, the British plantations possessed a far larger share of freedom than the colonies of any other country. Hence their progress, though incomparably less than it would have been had the government of the past adopted the wiser policy of the present, was immeasurably

greater than that of the dependencies of Spain and Portugal.

Nothing, indeed, could be worse than the colonial system adopted by these two countries. Every native of the colony was studiously excluded from the functions of government or even of administration; perhaps with the view of making independence impossible, by depriving the colonial population of the faculty of political action. We know, indeed, that if this were the motive, the government was baffled; but the evil effect remained, and remains still, in the state of chronic anarchy in which those countries have almost invariably been since the overthrow of Spanish and Portuguese authority in the New World. The history of Mexico since its independence is the most striking because the most obvious example of the effect of the colonial policy followed by Spain; and the utter demoralisation of the country is attested as well by the observation of travellers as by the complaints which have led to the interference of foreign governments in the affairs of the country.

The war which issued in the independence of our American colonies seems to have decided, in so far as experience can decide anything, the question as to the commercial importance of dependencies, and the extent of regulations on the trading intercourse of the colony and the mother country. No colonies were ever reckoned half so valuable as those which afterwards formed the republic of the United States; and it was generally supposed that their emancipation would be decisive of the fate of Britain—that her sun would then set, and for ever! But have we really lost anything by that event? Has our trade, our wealth, or our power been in any degree impaired by the independence of the United States? The reverse is distinctly and completely the fact. The question whether we could have continued for any length of time to retain such rapidly growing countries in a state of dependence, or that we could have been advantageously united in a federal union with vast regions situated in another hemisphere, is a barren and unprofitable speculation. But notwithstanding the independence achieved by the founders of the union, we have continued, and must necessarily continue, to reap all the advantage we can reasonably claim as founders of this mighty empire in the wilderness. Englishmen will generally command a preference in the American markets. And while we are disengaged from the thankless, unmanageable, and expensive office of governing or defending all but boundless countries 3,000 miles distant, our intercourse with them grows with their growth; and we are as much benefited and enriched by them as we should have been had they continued in the same state of dependence as Australia or the Cape of Good Hope.

The previous remarks are not, of course, meant to apply to such dependencies as Malta or Gibraltar. These are not colonies, but naval stations, held for military or political purposes, and retained on the understanding that they are essential to the maintenance of political relations. Their commercial value is nothing, and any attempt to argue their retention on such grounds as their importance to the mercantile interests of the country, is a piece of sophistry over and over again disproved.

Neither are the previous remarks meant to apply to the conquest and occupation of foreign countries, in the view of increasing national opulence and power. Such a conquest or occupancy is a matter of military interest only, in which too often the obstinate memory of past exploits, or the satisfaction felt at the power of inflicting injury, is all that can be quoted as compensating great concomitant evils. No sane Englishman would mourn over the loss of Cherbourg or Calais, held for centuries from the French, or regret that the principality of Aquitaine, the fruit of the victories of Edward III., was rapidly recovered to the same kingdom. It is certain that, if we are ever engaged again in a Continental war, the policy of this country will never be directed towards the permanent acquisition of any portion of European soil.

Sometimes, in order to carry on a trade with a colony, it is necessary to give its products peculiar advantages in the markets of the mother country; and consequently at the expense and to the prejudice of the consumers in the latter. No small portion of our trade with the West Indies was forced through the preference which their sugars enjoyed down to 1854 in our markets. The trade with Canada was also for a long while forced and factitious, depending as it did on the circumstance that the duties on colonial timber were very much less than the duties upon foreign timber, that is, on timber from the North of Europe. This preference was injurious both to the Canadians and to ourselves. It withdrew the energies of the former from the culture of the soil, the most advantageous pursuit to which they could be directed; and while it made us buy inferior timber at a comparatively high price, it narrowed our trade with the countries round the Baltic. Luckily, however, this preposterous policy has latterly been abandoned, and we are now permitted to buy timber, like sugar, wherever we find it cheapest and most suitable for our purposes.

Since these changes have been effected, the colonies in the West Indies and North America have lost much of their former prestige. They do not, in fact, produce a single article which we might not import as cheaply or cheaper from other countries. And as they furnish no surplus revenue, but, on the contrary, occasion a heavy expense for their security and protection, it is difficult to see what advantages they confer on us, or what injuries we should sustain by their becoming independent.

The people of Britain would do well to reflect dispassionately on the state of the Canadian question. There are not, perhaps, a

dozen men of sense in the empire who are not ready to admit that we derive no peculiar advantage from our connection with that possession, nothing to set against the heavy expense which it certainly involves; and, if so, what should be our policy in the mean time? Are we resolved to maintain an army of 10,000 or 12,000 men in Canada?—to expend, directly and indirectly, some two or three millions a year in preserving a mere nominal ascendency in a colony? If such be our determination, it may be doubted whether we have profited much by the dear-bought experience afforded by the American war. National pride may prevent our relinquishing this costly and barren dominion; but good sense, and the most obvious views of expediency, would seem to suggest the policy of voluntarily anticipating what there is every reason to think must in the end necessarily happen, and of providing for the independence of Canada under a system of friendly and mutually beneficial relations.

As more enlarged and sounder views of the real value of colonies have been diffused, the relations between them and the mother countries have been gradually changed. Intelligent people have been long convinced of the impolicy of attempting to direct the internal affairs of distant communities placed under very different circumstances to their own, and such interference is no longer attempted. In the English colonies these matters are now left to be decided upon by their different councils and assemblies. These bodies, which correspond in some degree to the Lords and Commons of this country, consist, the first, of members that are usually in part nominated by the crown, and in part elected, and the second, of members elected by the colonists mostly under a widely extended system of suffrage. Wherever a body of this sort is established, it constitutes with the governor the parliament of the colony, and to it all matters of local interest, including the imposition of taxes, are committed. A power is, however, reserved to the crown of disallowing such acts of any colonial assembly as might encroach on its just prerogatives, or be prejudicial to the interests of the empire at large. Appeals from the colonial courts are made to the Court of the Privy Council; and all matters in regard to the contracting of treaties and alliances, naval and military regulations, and the making of peace or war, are vested exclusively in the crown. But with these exceptions, all British colonies having legislative assemblies may be said to be in most respects entirely self-governed. 'If,' says Mr. Mill, in his valuable work on Colonial Constitutions, 'the experience of the past has not enabled us to anticipate all the details of future difficulties, it has at all events furnished irresistible evidence of the instability of those principles of colonial policy which were once deemed to be the pillars of our national greatness. To retain for the longest possible period, at the smallest possible cost, with the greatest possible advantage to ourselves, a permanent dominion over the dependencies of our empire, was once the problem which occupied the minds of British statesmen. To ripen those communities to the earliest possible maturity, social, political, and commercial—to qualify them, by all the appliances within the reach of a parent state, for present self-government and eventual independence, is now the universally admitted object and aim of our colonial policy'—(p. 69).

The maintenance of the existing relations between the colonies and the mother country, supposing neither party to take any step in the matter, depends upon a great variety of circumstances peculiar to each colony, which can neither be foreseen nor appreciated beforehand. At present all the substantial advantages of the connection appear to be on the side of the colonies; and it is difficult to see what they would gain by breaking it off. Hitherto we have kept large bodies of troops in New Zealand, Canada, and at the Cape of Good Hope, not because they were required for any imperial purpose, but that they might protect the colonists from the attacks of the natives, or from the dangers apprehended from powerful neighbours. But such a state of things should surely be put an end to. The colonies should be made acquainted with the cost as well as the advantages of self-government. They should be taught to provide that support for themselves which is now provided for them by others.

The large amount of military force kept on foot in British North America is not required for any imperial purpose, but is maintained to ward off any sudden attack on the part of the United States. But if Canada and British North America generally wish to preserve either their connection with this country or their own independence, they should make some greater efforts in either direction than they have made hitherto. It would hardly, indeed, be in our power to prevent these provinces being overrun, in the event of their being attacked by the Northern States, without greater exertions on the part of the colonists for their self-defence than any which they seem disposed to make. The advantages, if any, which we derive from our connection with British North America, are certainly not such as would justify, or warrant, our incurring any very great expense on its account. The colonists are themselves sufficiently powerful to resist any attacks on their independence; and if they decline doing this it is not worth our while to do for them what they can, but will not, do for themselves.

The real or supposed necessity of affording them efficient protection is a serious inconvenience which attaches to the possession of colonies in different and distant parts of the world. During war they cannot fail to absorb large portions of the force which may, perhaps, be required for the defence of the United Kingdom; and they may also afford vulnerable points which may be conveniently attacked by our enemies, and cannot be defended except

at an immense expense and great risk. Our numerous colonial possessions are a consequence of our long-continued superiority at sea, and the maintenance of that superiority in all parts of the ocean is indispensable to the continuance of our present preponderance as a colonial power. But we incline to think that it would be good policy to contract rather than extend the limits of the latter. And when a colony, whether in Australasia or America, has attained to such a degree of population and power that with ordinary prudence it may be capable of maintaining its independence, it may be doubted whether it should not be declared independent. We should, supposing this to be done, continue to derive the same or greater commercial advantages from it; and it would afford, as a free state, quite as desirable an outlet for emigrants as if it were a dependency. And, supposing we were engaged in war, we should not have to provide for its defence; nor could our enemies or rivals hope to injure us by quarrelling with a people that had become independent, and which it would rather be their interest to seek to conciliate. All cases of this sort must, however, be peculiar; and what might be good policy in regard to A might be inexpedient in regard to B. But on the whole it appears sufficiently clear that numerous and widely extended colonial possessions involve very grave responsibilities, and seem more likely to become a source of weakness than of strength to the mother country.

The explanation given by Dr. Smith in the *Wealth of Nations* (book iv. cap. vii.) of the causes of the rapid growth and prosperity of colonies founded in advantageous situations, though impugned by Sismondi (*Études sur l'Économie Politique*, ii. cap. 'Colonies') and others, seems to be consistent alike with principle and historical evidence. When a colony is founded in an uninhabited or but thinly peopled district, each colonist gets a large extent of the best land; he has no rent, and but few, if any, taxes to pay; and being able to procure supplies of manufactured articles from the mother country, or one equally advanced, he applies all his energies to agriculture, which under the circumstances is most productive. The demand for labour in such colonies is very great; for the high rate of wages, combined with the cheapness of the land, speedily changes the labourers into landlords, who in their turn become the employers of fresh labourers. In consequence population and wealth advance with unusual rapidity; and in some instances, as in that of the United States, they have continued for a lengthened period to go on doubling every twenty or five-and-twenty years!

But in stating that the facility of obtaining supplies of fertile and unoccupied land is the principal cause of the rapid progress of new colonies, it is not meant to affirm that it is the only cause. An advantageous situation for the prosecution of commercial pursuits, and great superiority in navigation, may enable a colony to advance at its outset, though without any considerable extent of territory, with even more rapidity than if it enjoyed an unlimited command of fertile land. This seems to have been the principal cause of the speedy extension of the old Greek colonies. The most famous of these, as Syracuse and Agrigentum in Sicily, Tarentum and Locri in Italy, and Ephesus and Miletus in Asia Minor, were amongst the principal emporia of the ancient world. They were all seaport towns; were founded in the most advantageous situations for carrying on an extensive commerce, and owed, in fact, their wealth and greatness mainly to trade and navigation. Owing, however, to the limited extent of their territorial acquisitions, a consequence partly of the difficulty of subduing the indigenous population, and partly of the neighbourhood of other colonies founded by rival states, their power rested on no very broad or solid foundation; so that the fall of the capital city and the annihilation of the state were all but synonymous.

The colonies founded in modern times have been placed under very different circumstances. The countries in which they were planted were either so very thinly inhabited as to be almost deserts, or they were occupied by a feeble and inferior race unable to oppose any effectual obstacle to the diffusion of the colonists; so that the latter easily spread themselves over a large extent of country, and have had in general more of an agricultural than of a commercial character. But while this has given them greater strength, it has not, after the difficulties attendant on their first establishment were got over, in any degree impeded their progress, but the contrary. The most flourishing of the ancient colonies cannot be compared in respect of rapidity of growth, magnitude and power, with the United States; and the slower progress of the Spanish and Portuguese colonies is not owing to the colonists having distributed themselves over a wide extent of country, but to the oppressive interference of the mother country with their domestic arrangements, and the vexatious restrictions laid on their intercourse with foreigners.

A very great degree of equality prevailed among the free settlers in Greek colonies; and in consequence the lands acquired by the colonists were distributed amongst them in nearly equal portions; but in modern times it is very different. Owing to the vast extent and almost desert state of the countries in which they have been principally planted, the poorest individuals have generally succeeded in acquiring slips of land; while the superior class of colonists, or those who had influence with the colonial government, or with that of the mother country, frequently succeeded in getting grants of vast tracts of land, not in the view of cultivating, but of holding them till in consequence of the increase of population in the vicinity they had acquired a considerable value.

These large reserves, by interrupting the communications between different parts of the colony, and increasing the difficulty and cost of conveyance, have frequently proved not a little injurious to its interests. But there are various ways in which an abuse of this sort might be obviated; one of the most obvious being that grants of land should revert to the colonial exchequer unless certain improvements were effected upon it within a specified time after the grant was made. The inconvenience and check to progress consequent on the appropriation of large portions of the lands in a new colony, whether such appropriation arose from the occupancy of the settler, or from prodigal grants on the part of the home government, have been manifest in the past history of several colonies, and among these in none more markedly than in the first founding of the Swan River settlement, now known by the name of West Australia. Here, though abundant capital was exported for all the purposes of successful occupation and progressive prosperity, the evil of dispersion over the surface of the territory was so serious, that great part of the capital exported was wasted, and the prospects of the colony were ruined.

This, with many other instances of domestic mismanagement on the part of the colonists, induced Mr. Gibbon Wakefield, an economist of great practical sagacity, to urge the adoption of a plan which it was hoped would check the tendency to dispersion, and induce that state of 'cooperation'—to use Mr. Wakefield's phrase—between the elements of capital and labour, as would guarantee, all other things considered, the continuous combination of both these elements. Cooperation, according to Mr. Wakefield, is either simple or compound. The former is illustrated, he says, by the fact that where two or more persons are engaged in combining their strength in a single result, the effect of the combination is considerably more than the separate efforts of either. For instance, two men pulling simultaneously at a rope will raise a greater weight than could be raised by the added amount of the individual efforts of each. Two greyhounds hunting together will kill more hares than the joint product of each hunting by himself.

Compound cooperation is not very different from the division of labour. Here there is a common result, indeed; as, for instance, the building of a house; but each of the contributors to the result is engaged on a different process, while all the kinds of labour converge to one end. Now the existence of these kinds of cooperation is essential towards the economical progress of a community, as soon as it passes beyond the rudest state of social life; and both are needed for the developement of agriculture. Yet the state of things which prevailed in colonies where squatting was permitted, or where vast tracts of land were easily procured, postponed indefinitely the prospect of any sound social or economical organisation.

Mr. Wakefield's plan, and it has been generally adopted in colonies, was to limit the expansion of the colony by treating all the territory contained within its boundaries as public property, not disposable except at a fixed price. The colonist, in short, had to buy the land which he purposed to cultivate; the fact that such a price had been given by the settlers being a practical guarantee against any subsequent departure from the principle, since the old settlers would not be disposed to admit incoming parties to occupation on better terms than those at which they had themselves obtained possession.

Some of the theoretical consequences of this practice will be adverted to under the head of RENT. One other, however, may be briefly dwelt upon here.

It is clear that the purchase money of land procurable on these terms is a distinct deduction from the settler's capital. If, for instance, a colonist emigrates with 500*l.*, and is desirous of occupying a farm of 200 acres, the regulation price of which is 200*l.*, his capital will be diminished by that amount, and by implication his power of employing labour, supposing such labour to be at hand. And it is certainly true that when, according to the old system, lands in the colonies were held by parties residing in England, such a diminution of the capital of settlers by purchase of part of such lands was a loss to the settlers and the colony.

But in the Wakefield scheme the evil was at least in part obviated. *The whole of the purchase money was expended in the transport of labour to the colony in which the sale was effected.* This in effect repaid the purchaser by rendering labour cheaper, and obviated the excessive tendency to dispersion over the soil. If it were an evil at all, and events make the evil remote or dubious, the benefits of the regulation vastly counterbalanced the inconvenience; and it may be confidently asserted, that, in the beginning at least of their history, the Australasian colonies have owed more to the adoption of the Wakefield scheme than to any other circumstance.

Mr. Wakefield's theory encountered much opposition. The objections taken to it are unimportant, and the controversy settled by the success of the theory in practice need not be revived.

Latterly, some colonial governments have instituted the system of granting lands to colonists who, paying their own passage money, have sufficient capital for cultivating such grants. Great and successful efforts in this direction have been made by the colony of Queensland. It is likely that such plans may induce the gradual and healthy occupation of these regions, though for a long time the near and superior attractions of the United States will absorb by far the largest number of the emigrating class.

Colophon (Gr. *a summit*: hence, *a finishing stroke*). In Bibliography, the postscript contained in the last sheet of an early printed

work (before the introduction of title-pages), containing the printer's name, date, &c., is so termed.

Colophonite. A brown variety of iron-lime Garnet with a *resinous* lustre.

Colophony. Common resin or *rosin*. The non-volatile portion of crude turpentine, so named after Colophon, in Ionia, whence resin was obtained by the Greeks.

Colossal (from Gr. κολοσσός, *a statue larger than life*). In the Fine Arts, a term applied to any work of art remarkable for its extraordinary dimensions. It is, however, more applied to works in Sculpture than in the other arts. It seems probable that colossal statues had their origin from the attempt to astonish by size at a period when the science of proportion and that of imitation were in their infancy. Colossal statues of the divinities were common both in Asia and Egypt. By the description of the palace or temple attributed to Semiramis, it abounded with colossal statues, among which was one forty feet in height. In Babylon we learn from Daniel that the palaces were filled with statues of an enormous size, and in the present day the ruins of India present us with statues of extraordinary dimensions. The Egyptians surpassed the Asiatics in these gigantic monuments, considering the beautiful finish they gave to such a hard material as granite. Sesostris is said to have been the first who raised these colossal masses; the statues of himself and his wife having been thirty cubits in height. This example was imitated by his successors, as the ruins of Thebes sufficiently testify, the two Memnons being still in existence. The taste for colossal statues prevailed also among the Greeks. The statue of the Sun at Rhodes was executed by Chares, a disciple of Lysippus; and the great Phidias contributed several works of this order. The colossus at Tarentum by Lysippus was no less than forty cubits in height; and the difficulty of removing it, rather than the moderation of the conqueror, prevented Fabius carrying it off with the Hercules from the same city. Before the time of the Romans colossal statues were frequently executed in Italy. The first monument of this nature set up in Rome was one placed in the capitol by Sp. Carvilius after his victory over the Samnites. This was succeeded in after times by many others, of which those now on Monte Cavallo, said to be of Castor and Pollux, are well known to most persons. The principal Roman colossus was the figure of himself, as the Sun, set up by Nero before the Golden House, near the site of the temple of Venus at Rome; it was in bronze, the work of Zenodorus, and if, as Pliny says, it was 110 feet high, it was larger than the colossus of Rhodes. The great Roman amphitheatre known as the Colosseum is supposed to have been so called because it was built on the site or place of this figure. In modern times the largest that have been erected are those of San Carlo Boromeo, at Arona near Milan, and the bronze 'Bavaria' of Schwanthaler at Munich, cast by Stiglmayer, nearly sixty feet high.

Colosseum. [AMPHITHEATRE.]

Colossochelys (Gr. κολοσσός, and χέλυς, *a tortoise*). A gigantic species of land tortoise, discovered by Messrs. Falconer and Cautley in the tertiary formations of India. This species was the largest Chelonian known to palæontologists. Its carapace measured more than twelve feet in length; and from its gigantic size it has been conjectured that the knowledge of it formed the base from which the mythical cosmogonies of the Hindus were derived.

Colostrum. The first milk after delivery.

Colour (Lat. color). In Painting, that quality of a body which affects our sensation in regard to its hue. *Local colours* are those which are natural to a particular object in a picture, and by which it is distinguished from other objects. *Neutral colours* are those in which the hue is broken by partaking of the reflected colours of the objects which surround them. *Positive colours* are those unbroken by such accidents as affect neutral colours.

Colours are divided into primary, secondary, and tertiary. The first are red, blue, and yellow; the second are orange, green, and purple; the third citrine, olive, and russet; all of which exist in a great variety of tints or hues. (Goethe's *Theory of Colours*, translated by Sir Charles Eastlake, 1840; and Field's *Chromatography*, &c. 2nd edit. 1841.)

Colours. Are the banners or flags of regiments of infantry. Each regiment has two, a royal and a regimental colour; on these are borne the devices, distinctions, badge and motto of the regiment, and its number, in gold characters. Crowned heads, princes, and field-marshals of our army are alone entitled to be saluted by lowered colours. The colours of a regiment are always saluted with the utmost respect by a guard, and it is customary for officers on the staff to salute colours when they are borne past at a review. The banners of regiments of dragoons are called *guidons*, and those of other cavalry regiments *standards*.

Colouring Matters. All nature abounds in these principles, and art has added to the number. The coloured appearance is not an inherent property of the body itself, but due to its effect upon ordinary light, which, as is well known, is composed of rays of all colours. If a body absorbs nearly all the light, it appears black. If it absorbs scarcely any, but reflects it or throws it off, it will appear white. But if the body contains any substance (pigment) that has the power of decomposing white light, its colour will depend upon which of the rays it absorbs and which it reflects. Strictly speaking, therefore, the *colour* of a pigment is due to light which it cannot absorb and which is reflected to the eye of an observer.

Coluber (Lat.). A Linnæan genus of serpents, including all those in which the subcaudal scale-plates or scutæ are arranged in pairs. This extensive group is now subdivided into numerous subgenera.

Columba (Lat. *a pigeon*). A genus of birds which form the transition from the Passerine to the Gallinaceous orders. They fly well; live in a state of monogamy; build their nests in trees or in the crevices and fissures of rocks; and lay but few eggs at a time, generally two; their tail is composed of twelve quill-feathers: so far the Columbæ resemble the Passerine birds. But their beak is vaulted; the nostrils perforated in a broad membranous space, and covered with a cartilaginous scale, which even forms a bulge at the base of the bill; the sternum is deeply and doubly notched; a dilated crop is developed from both sides of the œsophagus; the stomach is a true gizzard; and the lower larynx has only a single pair of muscles: all these important modifications of structure indicate the close affinity of the Dove tribe to the Gallinaceous birds. And it may be further remarked, that although the pigeons lay but few eggs at each brood, they breed frequently, and at short intervals. The male assists his mate in the business of incubation and rearing of the young, which are at first supported by a milky secretion prepared from the glandular coat of the crop, and regurgitated, together with the macerated grain. The Linnæan genus is subdivided into numerous but unimportant subgenera, characterised by the greater or less length of the bill, and the proportions of the feet and tail.

Columba Noachi (Noah's Dove). A small constellation formed by Halley, in the southern hemisphere, near the hinder feet of Canis Major.

Columbarium (Lat.). In Architecture, a pigeon-house or dove-cote. The arched and square-headed recesses in the walls of cemeteries, which were used to receive cinerary urns, were also called *columbaria*, from their resemblance to structures of this kind.

Columbite. This mineral is essentially a compound of columbic acid with the oxides of iron and manganese. It occurs in crystals, which are of a greyish or brownish-black colour, opaque, often iridescent, and possess a metallic lustre; and is found in granite in Bavaria, and in Massachusetts and Connecticut in North America.

Columbium. A metal discovered by Mr. Hatchett in 1801, in a mineral from Massachusetts in North America. [COLUMBITE.] It has been found in a Swedish mineral called Tantalite, but its ores are extremely rare. It is acidifiable, and hence the peroxide has been termed *columbic acid*.

Columelliaceæ (Columellia, one of the genera). An obscure natural order of shrubby or arborescent epigynous Exogens, inhabiting Mexico and Peru, and distinguished from *Jasminaceæ*, to which order they have been referred, by having an adherent ovary, an epigynous disc, undivided stigma, and inferior capsule with polyspermous cells. Of its true affinity little is known. Lindley places it in the Cinchonal alliance.

Columna (Lat. columna). In Anatomy, the term is applied to longitudinal portions or tracts of the myelon, of which there are three in each lateral moiety, called from their situation in the upright posture of man, *anterior middle*, and *posterior* columns.

COLUMN. In Architecture, a member of an order, the section through the axis of which is usually the frustum of an elongated parabola. It is circular on every height of its plan; and consists of a base, a shaft or body, and a capital. It differs from a pilaster, which is square on the plan. The use of a column is to support an entablature in classical architecture; in mediæval architecture it is frequently made to receive the springing of the arches of the upper structure.

COLUMN. In Military language, is a formation of troops, narrow in front, and deep from front to rear; whereas in *line* they display a long front with the least possible depth.

Columnæ Carneæ (Lat.). In Anatomy, the fleshy prominences from the inner surface of the ventricles of the heart. Some are conical, with free apices giving attachment to the threads 'chordæ tendineæ' attached to the valves; others extend from one part of the walls of the ventricle to another, and are sometimes called *trabeculæ*.

Colures (in Greek *αἱ κόλουροι γραμμαί, imperfect figures*). In Astronomy, two imaginary great circles of the celestial sphere intersecting in the poles of the world; one passing through the equinoctial points of Aries and Libra and the pole of the equator, and the other through the solstitial points of Cancer and Capricorn, and the poles both of the ecliptic and equator. For this reason the first is called the *equinoctial*, and the second the *solstitial* colure. The name is supposed to have been given to them because a portion of these circles is always concealed from view under the horizon.

Colza, Oil of. The oil expressed from the seed of the *Brassica oleracea campestris*, a kind of cabbage. Colza oil is much used in France and Belgium for burning in lamps and other purposes.

Coma (Lat.; Gr. *κόμη, hair*). The assemblage of branches forming the head of a forest-tree. Also used to denote bracts that are empty and terminate an inflorescence, as in *Salvia Horminum*.

COMA (Gr. *κῶμα*). Lethargy, or unnatural drowsiness; whence the term *comatose*.

Coma Berenices (Lat. *Berenice's hair*. 'The fame of this lock of hair has likewise been perpetuated by the word *vernice*, *vernis*, and *varnish*, which alludes to the amber colour of the queen's beautiful tresses:' Sir G. C. Lewis, *Astronomy of the Ancients*, p. 197). A constellation of the northern hemisphere, between the tail of the Lion and the Boötes. [CONSTELLATION.]

Comb or **Combe.** A measure of corn, commonly four Winchester bushels.

COMB or COOMB. In the western counties of England, signifies *a small valley*. The same ancient word of Celtic derivation is used in

Wales (cwm), and in the Alps between France and Piedmont (combe), in the same sense.

Combinant. According to Sylvester, a combinant is a covariant (or invariant) of two or more quantics, which possesses the additional property of remaining unaltered, a factor excepted, when the quantics are replaced by linear functions of themselves. Thus if

$$u = (a, b, c \between x, y)^2$$
$$\text{and } u' = (a', b', c' \between x, y)^2,$$
$$\text{then } ac' - 2bb' + ca'$$

is a combinant of u and u', since it is merely changed into

$$(a\beta_1 - a_1\beta)^2 (ac' - 2bb' + ca'),$$

when for the coefficients in u and u' we substitute the corresponding ones in

$$a\,u + \beta\,u' \text{ and } a_1\,u + \beta_1\,u'.$$

(*Phil. Trans.* 1853.)

Combination. In Law, may take place for the performance of any unlawful act, and is punishable before such act is executed. But the word has been commonly used in a particular sense; viz. that of a combination among workmen to demand wages at a particular rate; which was an unlawful act prior to the 6 Geo. IV. c. 129, repealing former statutes; now explained by 22 Vict. c. 34. Workmen are now at perfect liberty to form such combinations; but penalties are enacted by the statute against such as use threats or violence towards those who refuse to join in them. The offence of administering unlawful oaths (whether preparatory to a combination among workmen, or for any other purpose) remains unaffected by the statute.

Combinations among workmen for the purpose of raising the wages of labour, and the machinery employed for that end, namely, a trades' union, governed by a body of delegates from different associated 'trades,' or by persons appointed to watch over the interests of a particular 'trade,' with the threat of a strike, the object of which is to compel more favourable terms from employers by the suspension of work undertaken, are a characteristic feature in the present relations of labour and capital.

Endeavours on the part of labourers to exact better wages from employers are historically as old as the attempts to limit the rate of wages. The first statute, purporting to check the demand of labourers for higher payment, is the Statute of Labourers, passed after the great plague of 1348, and enacting under heavy penalties that customary rates of payment only should be made; the compensation provided for the workmen being an attempt by the same legislative action to secure low fixed, or nearly fixed, prices of provisions. It is needless to say that the latter enactment was wholly nugatory, and the former nearly so, though agricultural labourers were, as might be anticipated, brought more nearly within the provisions of the statute than mechanics could be.

From this time to the final abolition of all laws restraining the price of labour, Acts were passed amending and fortifying the precautions taken by the Statute of Labourers. In general, the magistrates of each county were empowered to fix, year by year, the rates at which labourers were to be recompensed. In other words, the parties apparently most interested in maintaining a low rates of wages were entrusted with the power to determine the rate, and to exact the penalties provided by the statute. It is necessary to mention this, because those who have criticised the action of labourers in the practice of combinations, have been too apt to forget that much of this practice is retaliatory on centuries of combination on the part of employers.

But though the combination of labourers may be excused, it cannot be, we think, defended. The sole argument in favour of the practice is that commonly alleged, that capital is strong, and labour, or rather the individual labourer, weak, and that the union is a defence against the tyranny of capitalists. It is also confidently stated that wages have been advanced by the threat of strikes implied in the act of combination. But the arguments against the practice are far more numerous and far more weighty. The rate of wages is naturally determined by the coordinate and reciprocal influence of supply and demand. If the former be scanty and the latter great, wages will rise; if the reverse, wages will fall.

The purpose of combination is to enhance wages by creating an artificial scarcity. As the number of existing labourers and the existing demand cannot be controlled, the only means by which this scarcity can be effected are by making the labour less efficient, by controlling the means by which fresh labourers can be introduced into the 'trade,' or by arresting the supply at some critical period. The first of these methods is attained by regulating the way in which a labourer should work; as, for instance, by insisting that he should not carry materials, or by determining the hours of labour; the second is achieved by the regulations all but universally in force about apprenticeship; and the third by the mechanism of a strike. The last of these methods alone materially affects the condition of the capitalist; and various precautions have been taken, in general successfully, against the loss which might ensue from the stoppage (for instance) of works under contract.

The other two consequences affect the public, that is, the general purchaser or hirer of the produce derived from the joint operation of the labourer and the capitalist. They affect him by raising the cost of production.

It is plain to everyone, that the value of a sum of money, whether it be income or wages, is wholly determined by what it will procure by purchase. It is also clear that, if labour be rendered less efficient, the loss will not fall on the capitalist or employer of labour, except indirectly, but upon the person who purchases the commodity procured by labour. This is the more evident when the commodity is a matter of primary necessity, as, for instance, lodging or shelter from weather. Now, if the

cost of a house be increased, as it probably is increased, fifty per cent. by the operation of a trades' union ramifying through all the artisans contributing to the building, the loss is equivalent to a gigantic tax levied on every occupier of a house or lodging through the whole country; and as house-rent represents a far higher percentage in the expenditure of the poor than in that of the rich, it falls with far greater severity on the very classes who have obtained an increase of money-payments in exchange for a diminution of purchasing power.

Again, the practice of combination discourages excellence in workmen. The tendency of a union is to classify the payment of wages. The employer may select his workmen, indeed, but the trades' union takes away the motive for greater energy, by denying that energy any larger remuneration.

Further, combination, to be just, should extend to all labourers; in other words, should effect a general rise in the price of labour. It is needless to say that a general rise in prices would leave everybody ultimately just where they were before the rise occurred, i.e. anybody would purchase less with more money. But the combination is possible only in particular trades or occupations. Hence, the fund for the payment of wages being a quantity, the class of labourers which can combine gets a larger, the class which cannot combine a less, quantity of the gross amount. The bricklayers and carpenters are enriched at the cost of the agriculturist or the sailor. And as the enhanced cost of the commodity supplied by the members of a trades' union is ordinarily a necessary of life, the uncombining labourers are mulcted anew by the increased cost of the commodity, and by the diminished power of purchase.

Lastly, the very existence of a system of combination stimulates, if it does not necessitate, the disposition to coerce those who are not inclined to take part in the union. It is almost a rule without exception, that where combinations are most general, outrages on non-unionists are most common. It is true that all combinations denounce in theory the practice of coercion or persecution on those who decline to take part in the system. But the disavowal is very different from the abandonment of the practice. Viewed as combinations are by workmen, as the means namely by which they achieve greater wages, and as the sole barrier between themselves and what they call the tyranny of capitalists, the man who stands aloof from them is not only looked upon as selfish, and wanting in *esprit de corps*, but as a traitor to his order, and as hostile to the material prosperity of his fellow-workmen. It is very hard, under such impressions of passive dislike and distrust, to check the disposition towards the manifestation of these feelings by acts of hostility and violence.

This sketch of some among the economical consequences of combination does not exhaust the subject. We shall have occasion to revert to certain further principles on the relations of labour and capital, when we speak of LABOUR, TRADES' UNION, and WAGES.

It is needless to say that the subject is treated of by most political economists, and the reader may be referred to almost any system of the principles of political economy for further arguments for and against the practice of combination among workmen, for the purpose of raising the money wages of labourers.

Combinations. In Algebra, are the different arrangements of a number of objects (letters) into groups of a given nature. In combinations no regard is paid to the order in which the objects are arranged in each group, whilst in variations and permutations this order is respected. The number of different combinations, m in each, of n different letters is

$$\frac{n(n-1)\,.\,.\,(n-m+1)}{1\,.\,2\,.\,.\,.\,.\,.\,.\,.\,m}.$$

Since each combination of m letters must leave a complementary one of $n-m$ letters, it follows that the above number is also equal to

$$\frac{n(n-1)\,.\,.\,(m+1)}{1\,.\,2\,.\,.\,(n-m)}.$$

Thus there are

$$\frac{5\times4\times3}{1\times2\times3}=\frac{5\times4}{1\times2}=10$$

combinations of 5 letters, whether taken in triplets or in pairs. When an unlimited supply of objects of n distinct kinds is given, and into each combination of m two or more objects of the same kind may enter, the total number of different combinations will be

$$\frac{n(n+1)\,.\,.\,.\,(n+m-1)}{1\,.\,2\,.\qquad m}.$$

This, for instance, represents the number of homogeneous powers and products, of the m^{th} dimension, that can be formed with n letters, in other words the number of terms in a n-ary m-ic, which is the same as the number of terms in the expansion of $(a_1+a_2+\,.\,.\,.\,a_n)^m$. [QUANTIC.] Thus a binary m-ic contains

$$\frac{2\,.\,3\,.\,.\,.\,(m+1)}{1\,.\,2\,.\,.\,.\quad m}=m+1$$

terms; a ternary one,

$$\frac{3\,.\,4\,.\,.\,.\,(m+2)}{1\,.\,2\,.\,.\,.\quad m}=\frac{(m+1)(m+2)}{1\,.\,2};$$

a quaternary one,

$$\frac{4\,.\,5\,.\,.\,.\,(m+3)}{1\,.\,2\,.\,.\,.\quad m}=\frac{(m+1)(m+2)(m+3)}{1\,.\,2\,.\,3\,.};$$

and so on. A complete *non-homogeneous* algebraic expression of the m^{th} degree in one, two, three, &c. . . . . variables contains, of course, as many terms as a binary, ternary, quaternary, &c. . . . m-ic, since it can be made homogeneous by introducing an additional variable. The above formulæ for combinations, *without* and *with repetitions*, are the ones most frequently required in practice: their demonstrations, as well as further details, will be found in any treatise on Algebra.

Combining Proportion. [EQUIVALENTS, CHEMICAL.]

Combining Volume. The volumes or spaces occupied by bodies in the gaseous or vaporous condition which combine chemically together. This volume can be determined by experiment or by calculation. If the atomic weight (combining weight) of a body be divided by its specific gravity in the gaseous state, the quotient will be its combining volume. Such quotients will of course only express the relation between the several volumes. The relation of atomic or combining volumes to each other is a simple one. One to one, one to two, and one to three are the common numbers.

Combretaceæ (Combretum, one of the genera). A natural order of shrubby or arborescent Exogens, of the Myrtal alliance, all living within the tropics. They possess astringency, and some are employed in dyeing. Some are polypetalous, some apetalous. They are especially distinguished by their convolute embryo.

Combustion (Lat. combustio, from comburo, *I set on fire*). This term is generally applied to the phenomena exhibited by burning bodies, and which depend upon the rapid union of the *combustible* with the oxygen of the air. The evolution of heat and light which attends this process announces intense chemical action; and we consequently find that combustion is always attended by the production of new compounds. [HEAT.]

Combustion, Spontaneous. [IGNITION.]

Comedy (Gr. κωμῳδία, perhaps from κώμη, *a village*, and ᾠδή, *a song*, because the original rude dialogues, intermixed with singing and dancing, out of which the early Greek comedy arose, were sung by rustic actors at village festivals). A species of drama, of which the characteristics in modern usage are, that its incidents and language approach nearly to those of ordinary life; that the termination of its intrigue is happy; and that it is distinguished by greater length and greater complexity of plot from the lighter theatrical piece entitled a *farce*. The original Attic comedy was a burlesque tragedy in form, in substance a satire on individuals, and founded on political or other matters of public interest. The modern comedy is derived from the new comedy of the Greeks, of which Menander and Philemon were the principal authors, and which has been preserved to us through the Latin imitations of Plautus and Terence. [DRAMA.]

Comenic Acid. When a solution of *meconic* acid in water, or in dilute sulphuric acid, is long boiled, or when dry meconic acid is heated to 400°, it is converted into a modified bibasic acid, water and carbonic acid being at the same time evolved. The formula of comenic acid is $C_{12}\ H_2\ O_8\ +\ 2\ H\ O$.

Comet (Gr. κομήτης, from κόμη, *hair*). The name given to a numerous class of celestial bodies belonging to the solar system.

The ancients gave the name of *comet* to every nebulous star or meteor which was observed to pass successively through different constellations. Some of the ancient philosophers regarded comets as simple meteors, engendered in the atmosphere. In order, however, to be convinced that they occupy a far more remote situation, it is only necessary to compare simultaneous observations at very distant places on the earth. Tycho Brahe was the first who showed that their true place is in the planetary regions. Modern astronomers apply the name, notwithstanding the etymology, to bodies which have neither nebulosity nor tail; excluding, however, luminous meteors from the category. The distinctive characters of a comet are: 1st. That it possesses a proper motion round the sun; 2nd. That it traverses space in a curve more elliptical than the orbits of the planets, and generally so elongated that in the distant parts of its orbit it ceases to be visible. The proper motion distinguishes comets from those new stars which occasionally appear, and become extinguished without changing their place in the sky. The elongated form of the orbit establishes a distinction equally marked between the comets and the planets. They revolve about the sun according to regular laws, similar to those which govern the planetary motions.

Comets are only visible during the short time they are near the perihelia of their orbits. The revolution of all the planets round the sun is performed from west to east in the order of the signs: comets, on the other hand, appear to traverse the heavens in all directions indifferently. Of some 280 comets whose orbits have been determined, about one-half have their motion direct. Their orbits also intersect the ecliptic at all possible angles. Out of the whole number there are only nine whose returns to the sun in successive revolutions have been verified by observation.

These comets are the following:—

	Period. Years	Next Return	
1. Encke's	3·29	1868,	October.
2. De Vico's	5·46	1866,	?
3. Winnecke's	5·54	1869,	June.
4. Brorsen's	5·58	1868,	May.
5. Biela's	6·61	1866,	January.
6. D'Arrest's	6·64	1870,	October.
7. Faye's	7·44	1866,	February.
8. Méchain's	13·60	1871,	October.
9. Halley's	75·00	1910,	?

Sir Isaac Newton was the first who submitted the motion of a comet to calculation, and pointed out a method of determining its orbit from three of its observed positions. Halley applied Newton's method to a great number of comets, of which the positions had been observed; and on comparing the resulting elements, perceived that the comet which appeared in 1682 moved nearly in the same orbit with one which had been observed in 1607, and another which had been observed by Apian in 1563. He therefore predicted its return in 1759—a prediction verified by the fact.

The computation of a comet's return to its perihelion is a work of great difficulty and labour; for in consequence of the attractions of the larger planets, the path of the comet may be considerably changed at each revolution, and all these changes or *perturbations*, as they are called, must be computed from the theory of gravitation.

The elements of a parabolic orbit—and in consequence of the facility with which it lends itself to calculation such an orbit is generally first assigned to a comet—are as follows:—

- τ. The time at which it makes its nearest approach to the sun. [PERIHELION PASSAGE.]
- ϖ. The longitude of the place which it then occupies as seen from the sun.
- ☊. The longitude of the place it occupies when passing upwards through the plane of the earth's orbit as seen from the sun. [NODE.]
- q. The distance from the sun to the comet at its nearest approach. The unit generally chosen is the earth's mean distance from the sun.
- ι. The angle which the path of the comet makes with the plane of the ecliptic.

We must also know the direction, whether direct, like the planetary motions, or retrograde; and if the orbit after all be found to be an elliptic one, we must know e the eccentricity.

Modern science has entirely exploded the notion of the destructive powers of comets. They are more passive than active; thus, Lexell's comet was entangled for some four months among the satellites of Jupiter, and only got away at last with an entirely new orbit, and yet the motion of the smallest satellite was not in the least deranged; there is also good reason for believing that we actually passed through the tail of the comet of 1861.

Encke has turned to account the voyages of these almost massless bodies into the depths of space, in enquiring whether there is in space a medium which resists motion, as it is in such bodies that a resistance of this kind would make itself felt. In the gradually diminishing period of his own comet, which is now less by two days than it was in 1789, he sees a proof of the existence of this medium. The consequences which follow from its presence in the planetary spaces are so grave, that although it is difficult to imagine the resistance offered to be *nil*, we must wait for further confirmation before it be accepted.

We have been richly favoured in the appearances of comets during the last few years. 1858 and 1861 will ever be red-letter years in the cometary calendar.

The great comet of 1858, or, as it was generally called during its visibility, the comet of Donati, was discovered by that astronomer on the 2nd of June in the constellation Leo, while it was yet distant from the earth 240,000,000 miles and more than 210,000,000 miles from the sun. Towards the end of August it was visible to the naked eye, but there was nothing deserving of mention in its appearance until about September 15, when it had arrived within one hundred and fifteen millions of miles from the earth, fifteen days prior to the perihelion passage. At this time commenced those indications of violent action upon the nucleus which afterwards riveted the attention of observers with the telescope. From the 2nd of June to the 8th of September, the earth was on the north side of the plane of the orbit; it crossed the line of nodes on the last-named date, giving an opportunity for observations on the figure of a section of the tail in a plane at right angles with the orbit, and upon other interesting features. In short, this comet is at once the most interesting and the best observed one on record, and we shall be doing our readers the best possible service by transcribing some of the conclusions arrived at by Professor Bond, whose monograph upon it is by far the most valuable contribution to cometary astronomy that we possess. In the last volume of the *Memoirs of the Royal Astronomical Society* will also be found a series of engravings of the telescopic appearance of the comet from drawings made by Warren de la Rue, Esq., F.R.S., with his Newtonian reflector of thirteen inches' aperture, the same instrument with which his well-known pictures of Saturn, Jupiter and Mars were drawn.

Professor Bond, comparing the results of all the observations, finds that the limiting surface of the head of the comet had a close resemblance to a surface generated by the revolution of a catenary on its vertical axis.

The tail was dark at its centre and branched; the right branch was brightest till the sun was reached, but between the 4th and 10th of October the left branch and envelopes became brightest. The branches were about this time distinctly separated by a conspicuous dark zone; this zone, at first narrow and dark, widened and gradually became indistinct.

Besides the dark zone, there was a much narrower dark canal with straight sides, which could be traced quite to the nucleus; it seemed as dark as the background of the sky. It inclined to the apparent right-hand of the axis of the tail, bringing it nearer to the direction of the radius vector.

The diameter of the actual solid nucleus must have been less than five hundred miles: the increase of size at the longer distances from the earth and sun, which is clearly indicated by the observations, was probably the effect of the dense haze of nebulosity surrounding it, which prevented its true limits from being seen.

On the 2nd of October, when the brightness of the head of the comet reached its maximum, it was 6,300 times brighter than on June 15th, the increase by observation exceeding that computed by the usual formula of the product of the inverse squares of the distances from the sun and earth, by thirty-three times.

One of the most important of the phenomena presented by the envelopes, was their regular succession and continuous ascent or expansion outwards from the nucleus. Seven distinct

envelopes have been recognised, and their history partially recovered.

The inner envelopes were observed to crowd upon the outer ones in a very remarkable manner. Bond suggests three theories:—

1. That the elevation-velocity may have been least in the earlier envelopes, causing them to be overtaken by their successors. On this point it is shown that the measurements present no such tendency in the initial velocities, but rather the contrary.

2. It is supposed that the intervals between successive envelopes may have been least in the earlier members of the series, so as to produce the appearance in question. But this also is opposed to the observations.

3. The remaining hypothesis, of a progressive diminution in the velocity of expansion for each envelope, is fully sustained by their measured breadths, in which a change of velocity is clearly exhibited.

The period between the elevation of the envelopes is found to have varied irregularly from four days sixteen hours, to seven days eight hours.

For a few days the surface of the envelopes was closed on the side opposite to the sun, although here and there penetrated by streams issuing into the tail principally from the cusps on either side. As it expanded, the discharge became general, but was always most considerable from the outside, thus forming the asymptotic branches below the nucleus. The curve on the side towards the sun in a completely formed envelope was very nearly circular for 60° or 80° on either side of the axis. This was originally the brightest and best defined region, but it was also the first to fade away, the material being evidently transferred to the outlines below the parallel of the nucleus, which remained in sight long after the upper portions had disappeared, and had been finally driven off into the tail. The process of dissipation furnishes a satisfactory explanation of the branches of the tail, which are simply the continuation of the old envelopes merged together and undistinguishable from each other, excepting near the nucleus. In this view the dark hollow of the axis represents the region not fully supplied from the envelopes, while they retained their closed or partially closed surfaces. In one instance, the materials of an envelope remained near the nucleus for eighteen days before they were expelled into the tail; it may hence be inferred that the particles do not at once acquire the property which subjects them to solar repulsion.

Several results of considerable importance have been arrived at from observations of the dark and bright spots observed on the envelopes; these are:—

1. A degree of permanence in the internal distribution of the substance of the envelopes retained for a long interval after their ejection from the nucleus.

2. That their diversified aspect, especially the isolation of bright masses, cannot be explained as a mere optical effect produced by the intersection or separation of streams of luminous matter passing out continuously from the nucleus into the tail.

3. The nearly permanent direction maintained by the spots relatively to the axis of the tail, proves that there was no sensible rotation of the envelopes, excepting in a sense always preserving an unaltered aspect towards the sun.

4. That there was no sensible oscillatory motion of the nature of that seen in Halley's comet, as described by Bessel.

5. The repetition of spots and rays, and other similar peculiarities of structure in successive envelopes, in nearly the same direction, strongly indicates that the nucleus itself constantly maintained the same aspect towards the sun without sensible rotation, other than is implied in this condition, and without oscillation. This result, notwithstanding the absence of observed oscillations, implies the action of polar forces upon the nucleus in the manner suggested by Bessel in his explanation of the phenomena of Halley's comet.

An outer faint veil, or *umhüllung*, was another feature of this king of comets. Mr. de la Rue's micrometrical measures on October 2, give the following real dimensions: Diameter of the nucleus 970 miles; breadth of first sector 6,470 miles, and its height from nucleus 4,460; height of third sector 11,980 miles; breadth of narrow channel in the tail 3,120 miles; at a distance of 255,850 miles from the outside bright head of coma, the tail was 219,300 miles broad; the centre of the dark channel was 109,650 miles from either side of coma. We may remark in conclusion that the last published (*Astronomische Nachrichten*, No. 1,524, April 27, 1865) elements of this comet assign a period of 1880 with an error of $\pm 6\frac{1}{2}$ years.

The great comet of 1861 presented a succession of eleven envelopes rising at regular intervals on every second day. Their evolutions and final dissipation were accomplished with much greater rapidity than the corresponding phenomena of the comet of 1858. Discovered in Australia in May, it made its appearance in these latitudes on the evening of June 30, when its aspect in the north-west was grand in the extreme. The nucleus was hardly inferior in brilliancy to Venus, and certainly superior to Jupiter; while the tail was traced in this country fully 90°, and in the clear atmosphere of Rome no less than 118°, from the head. The comet had passed its nearest point of approach to the earth about noon on the same day, and was then separated from us rather less than thirteen millions of miles. If, to determine the length of the tail, we compute from Professor Secchi's estimate at midnight on June 30, which assigns, for the angular extent, 118°, it will be found that the true length, assuming the principal tail to be a prolongation of the radius vector, or line joining the sun and comet, would be less than twenty millions of miles, which is by no means an unusual figure. We speak of the *principal* tail, or the long straight ray everywhere visible; but there existed, in addition to this, a secondary and

much less conspicuous train of diffused light, emanating from the nucleus in an arched form, which was more particularly noticed between June 30 and July 4, though chiefly by practised observers; and this leads us to mention a very interesting circumstance in the history of the comet. About the time of the nodal passage (June 28, evening) it was remarked that the earth was behind the comet only 2 degrees in longitude, as seen from the sun; and the latter body being the nearer to that luminary, it followed that the direction of the tail was such as to bring it either upon or very near to our globe. Accordingly it was conjectured that, with due allowance for curvature, it was quite possible the earth might have been involved in the tail on the evening of June 30, when she arrived at the comet's nodal point of longitude. Observations subsequently published, which enable us to determine the true direction of the tail with more certainty, appear to indicate that the main branch was in advance of the earth on that evening, but that the secondary tail, or the diffused nebulosity which separated from the principal ray, was actually directed upon us and was probably intermingled with our atmosphere. And it is a remarkable and significant fact, that not only in various parts of England and Ireland, but also in Spain, Italy, Switzerland and other Continental countries, a very peculiar phosphorescence or illumination of the sky was perceptible during the early hours of the night in question, which many persons supposed to be caused by the aurora borealis, unusual as the phenomenon is in the summer months, especially in the South of Europe; at the same time it was remarked that the luminosity of the sky did not resemble the usual effect of the aurora, but was something quite exceptional. We incline to attribute the phenomenon to the presence of cometic matter (if matter it can be termed) in our atmosphere.

'In concluding this brief summary of the more prominent points of interest afforded by the great comets of 1858 and 1861, it may be observed that the physical phenomena they exhibited had been for the most part previously witnessed in certain conspicuous comets, and particularly in the famous comet of Halley at its last appearance, but had never been watched with such advantages of optical power and score of practised observers as in those years. Bessel's theory of opposite polarities is the only one which seems to explain them even in part, but it would be difficult to render his views intelligible to the general reader within the limits of this notice.'

Cometarium. An astronomical toy, intended to represent the motion of a comet about the sun. Any instrument capable of describing an elongated ellipse may be called a *cometarium*. [ELLIPTIC COMPASSES.]

Comitia (Lat.). In Ancient History, the assemblies of the Roman people, which were of three kinds, distinguished by the epithets *Curiata*, *Centuriata*, and *Tributa*.

1. The Comitia Curiata were the assemblies of the patrician houses or *populus*; and in these, before the plebeians attained political importance, was vested the supreme power of the state. The name *Curiata* was given because the people voted *in curiæ*, each curia giving a single vote representing the sentiments of the majority of the members composing it; which was the manner in which the tribes and centuries also gave their suffrages in their respective comitia. After the institution of the Comitia Centuriata, the functions of the curiata were nearly confined to the election of certain priests, and passing a law to confirm the dignities imposed by the people.

2. The Comitia Centuriata were the assemblies of the whole Roman people, including patricians, clients, and plebeians, in which they voted by centuries. By the constitution of the centuries these comitia were chiefly in the hands of the plebeians, and so served originally as a counterpoise to the powers of the comitia curiata, for which purpose they were first instituted, it is said, by the lawgiver king Servius Tullius. These comitia quickly obtained the chief importance, and public matters of the greatest moment were transacted in them; as the elections of consuls, prætors, and censors, and the passing laws and trials for high treason.

3. The Comitia Tributa were the assemblies of the plebeian tribes. According to the popular tradition, they were first instituted after the expulsion of the kings; and in them were transacted matters pertaining to the plebeians alone, as the election of their tribunes and ædiles.

Comity of Nations (Lat. comitas, *courtesy*). Is defined in International Law to be the usage or practice which mitigates the severity of right *stricti juris* in the intercourse between civilised nations. (Phillimore *On International Law*, part iii. ch. i.) Thus it has been a question much debated whether international comity did not require the mutual surrender of criminals: although this is now in practice provided for by extradition conventions. Or, to take the simplest case, the absolute right of a state to dismiss foreigners from its limits (called by French writers *droit du renvoi*) is mitigated by the ordinary *comity* which allows the subjects of one state to dwell peaceably in another.

Comma. In Grammar. [PUNCTUATION.]

COMMA (Gr.). In Music, a very small interval, being about the ninth part of a tone.

Command. In Fortification, the height of one work above another, or above the ground, measured from the crests of the parapets.

Commander. In the Royal Navy, is the intermediate rank between lieutenant and captain. In large vessels there is a commander as well as a captain. In sloops, and vessels of that class, the commander is the senior officer. A commander ranks with a lieutenant-colonel in the army, but as junior of that grade. His pay is 301*l*. 2*s*. 6*d*. per annum, with 45*l*. 12*s*. 6*d* additional if in chief command.

Commander-in-Chief. The officer in whom is vested the supreme command of all the land forces of the British Empire. This officer is appointed by the sovereign, and is supposed to enjoy the confidence of the ministry. He acts in conjunction with the Secretary of State for War, and is assisted in the discharge of his duties by several subordinate officers, such as the ADJUTANT-GENERAL, the QUARTERMASTER-GENERAL, &c. [see these terms], who are each at the head of a particular department.

There is also a commander-in-chief in India, who is subject to the commander-in-chief at home.

A naval commander-in-chief is the flag officer who commands the squadron or fleet in a particular ocean-district.

Commandery or **Preceptory.** According to the usages of some orders of Knights, a district attached to a manor or chief messuage under the control of a member of the order, who receives the income of that district arising from the estates of the order, taking out of it his own pension, and accounting for the rest.

Commelinaceæ (Commelina, one of the genera). A natural order of herbaceous Endogens, chiefly inhabiting the East and West Indies. They are referred to the Xyridal alliance, and characterised by three sepals opposite the carpels, three petals, six (or three) stamens, axile placentæ, and a trochlear embryo. The species, often mere weeds, are occasionally beautiful flowering plants. A common example is the *Tradescantia virginica.*

Commendam, In (Low Lat.). A term of the Canon Law. A person to whom custody of a void ecclesiastical benefice is committed by the superior, without the profits appertaining to it, was said to hold the benefice *in commendam*, i.e. *entrusted to his care*; but by various devices the restriction on the receipt of profits was evaded, and the holding benefices in commendam became a mode of enjoying pluralities. By the English law, no one can hold in commendam without license from the crown. An ordinary case is where clergymen promoted to bishoprics with insufficient revenues are allowed in this manner to retain the profits of livings.

Commensurable (Lat. con, and mensura, *a measuring*). Two or more quantities of the same kind are said to be commensurable when each contains, an exact number of times, some other quantity of a like kind. Hence commensurable quantities are always proportional to certain whole numbers, and conversely all quantities are commensurable which are proportional to any series of whole numbers, or, we may add, fractions; since the latter, after reduction to a common denominator, are proportional to their numerators. In the expression of quantities by numbers, therefore, the commensurability of the former is tacitly assumed, whereas it can be shown that, *in general*, they are not so. No measure of the side of a square, for instance, however small the same may be, is contained an exact number of times in its diagonal. [INCOMMENSURABLE.] Hence arises an imperfection in the application of algebra, or arithmetic, to geometry; an imperfection which Euclid has avoided in his admirable fifth book. It is evident that the sum or difference of any multiples of two commensurable quantities must be commensurable with each; and, on the other hand, that every common measure of one of two quantities, and the sum of difference of any multiples of these quantities, must also be a measure of the second quantity.

Commentary (Lat. commentarius). In Literature, a word used in different significations: 1. In the same sense with *memoirs*, as a short narrative of particular events and occurrences, composed by an actor or spectator of those events with the professed object of calling back the circumstances to his own mind; e. g. the *Commentaries* of Cæsar. 2. Critical observations on the text or contents of a book. These are either in the form of detached notes, containing remarks on particular passages; or they are embodied in what is termed a *running commentary*, or series of remarks written and printed in a connected form.

Commerce (Lat. commercium, from con, and merx, *wares* or *merchandise*). The exchange of one sort of produce or service for some other sort of produce or service.

Exchanges of this description have their rise in the nature of man and the circumstances under which he is placed, and their origin is coeval with the formation of society. The varying powers and dispositions of different individuals dispose them to engage in preference in particular occupations; and in the end every one finds it for his advantage to confine himself wholly or principally to some one employment, and to barter or exchange such portions of his produce as exceed his own demand, for such portions of the peculiar produce of others as he is desirous to obtain and they are disposed to part with. The division and combination of employments is carried to some extent in the rudest societies, and to a very great extent in those that are most improved; commercial intercourse being developed in exact proportion to the progress of the social state. The division of employments could not exist without commerce, nor commerce without the division of employments: they mutually act and react upon each other. Every new subdivision of employments occasions a greater extension of commerce; and the latter cannot be extended without contributing to the better division and combination of the former.

In rude societies, the principal business of commerce, or the exchange of one sort of commodities for some other sort, is carried on by those who produce them. Individuals having more of any article than is required for their own use endeavour to find out others in want of it, and who at the same time possess something that they would like to have. But the difficulties and inconveniences inseparable from a commercial intercourse carried on in this way are so obvious as hardly to require being pointed out. Were there no merchants or

dealers, a farmer, for example, who had a quantity of wheat or wool to dispose of, would be obliged to seek out those who wanted these commodities, and to sell them in such portions as might suit them; and having done this, he would next be forced to send to, perhaps, twenty different and distant places, before he succeeded in supplying himself with the various articles he might wish to buy. His attention would thus be perpetually diverted from the business of his farm; and while the difficulty of exchanging his own produce for that of others would prevent him from acquiring a taste for improved accommodations, it would force him to endeavour to supply such things as were essential by his own labour and that of his family; so that the division of employments would be confined within the narrowest limits. The wish to obviate such inconveniences has given rise to a distinct mercantile class. Without employing themselves in any sort of production, merchants or dealers render the greatest assistance to the producers: they collect and distribute all sorts of commodities; they buy of the farmers and manufacturers the things they have to sell; and bringing together every variety of useful and desirable articles in shops and warehouses, enable all persons, without difficulty or loss of time, to supply themselves with whatever they want. Continuity is in consequence given to all the operations of industry; for, as everyone knows beforehand where he may dispose to the best advantage of all that he has to sell, and obtain all that he wishes to buy, an uninterrupted motion is given to the plough and the loom. Satisfied that they will have no difficulty about finding merchants for their produce, agriculturists and manufacturers think only how they may improve and perfect their respective businesses. Their attention, no longer dissipated upon a variety of objects, is fixed upon one only. It becomes the object of everyone to find out machines and processes for facilitating the separate task in which he is engaged; and while the progress of invention is thus immeasurably accelerated, those who carry on particular businesses acquire that peculiar dexterity and *sleight of hand* so astonishing to those who live in places where the division of labour is but imperfectly established. Facility of exchange is, in truth, the vivifying principle, the very soul of industry; and no interruption is ever given to it without producing the most ruinous consequences.

The merchants, or dealers, collect their goods in different places in the least expensive manner; and by carrying them in large quantities at a time, they can afford to supply their customers at a cheaper rate than the latter could supply themselves. Not only, therefore, do they, by enabling every employment to be carried on without interruption, and the divisions of labour to be perfected, add prodigiously to the powers of industry, and, by consequence, to the wealth of the community, but they also promote the convenience of everyone, and reduce the cost of conveyance and transfer to the lowest limit. According as commerce is extended, each particular business becomes better understood, better cultivated, and carried on in the best and cheapest method: where it is far advanced, the whole society is firmly linked together; every man is indebted to every other man for a portion of his necessaries, conveniences, and enjoyments; everything is mutual and reciprocal; and a large country becomes in effect, from the intimate correspondence kept up through the medium of the mercantile class, like a large city.

The mercantile class has been divided into two leading classes—the wholesale dealers and the retail dealers. This division, like the divisions in other employments, has grown out of a sense of its utility. The wholesale merchants buy the goods at first hand of the producers; but instead of disposing of them to the consumers, they generally sell them to the retailers or shopkeepers, by whom they are retailed or distributed to the public in such quantities and in such a way as is most suitable for them. The interest of all parties is consulted by this division. Had the wholesale dealers attempted also to retail their goods, they could not have given that undivided attention to any part of their business so necessary to insure its success. A retailer should be constantly at his shop; not merely that he may attend to the orders daily sent to him, but that he may learn all that may happen with respect to the situation of his customers, their wants and their circumstances. But wholesale dealers being obliged to attend to what is going on in different and distant quarters, cannot give this minute attention to what happens in their immediate vicinity; and even if they could, the capital required to carry on a wholesale business would not be sufficient for that purpose, were the business of retailing joined to it. Were there only one class of merchants, the capital and the number of persons employed in commercial undertakings would not probably be less than at present; but the merchant, being obliged to apply himself principally to one department, would have to leave the chief share of the other to servants; a change which, as every one knows, would be accompanied by the risk consequent on intrusting one's own business to others. There can, therefore, be no doubt that the separation in question has been highly advantageous. The classes of merchants, like those of artificers, are mutually serviceable to each other and to the public.

In a highly civilised country like Great Britain, the trade in every commodity in considerable demand, as corn, sugar, tea, timber, &c., affords employment for a separate class of traders. But for all purposes of general enquiry, it is sufficient to consider commerce under three heads, viz.: 1. The Home trade, or that carried on between individuals of the same country; 2. Foreign trade, or that carried on between individuals of different countries; and 3. The Colony trade, or that carried

on between the inhabitants of any particular country and its colonists. We subjoin a few remarks upon each of these heads.

I. *Home Trade.*—It has been already seen that the varying capacities and dispositions of different persons occasion the introduction of a division of employments, and the practice of exchange or barter. But the external circumstances under which men are placed vary still more than their natural powers or tastes. One set inhabit a rich fertile plain, suitable for the growth of corn and other analogous crops. Another set inhabit a mountainous district, the soil of which is comparatively sterile, but which is well fitted for rearing cattle; another set are planted upon the margin of a river, or arm of the sea, abounding in every facility for carrying on the business of fishing; and so on. Now it is obvious, that though the individuals belonging to any particular district had not established a division of labour amongst themselves, it would be highly for their advantage to establish one with those occupying other districts, the productions of which are materially different. When the inhabitants of Newcastle apply themselves principally to the coal trade, those of Essex to the raising of wheat, and those of the highlands of Scotland to the raising of cattle and wool, each set avail themselves, in carrying on their employments, of the peculiar powers of production conferred by Providence on the districts they occupy; and by exchanging such portions of their produce as exceed their own consumption, for the surplus articles raised by others, their wealth and that of everyone else is immeasurably increased. It is in this *territorial division of labour*, as it has been happily designated by Colonel Torrens, that the main advantage of commerce consists. In commercial countries, each individual may not only enter at pleasure on such pursuits as he deems most advantageous, but the entire population of districts and provinces are enabled to turn their energies into those channels in which they are sure to receive the greatest assistance from natural powers. Suppose England were divided into separate parishes, or even counties, surrounded respectively by Bishop Berkeley's wall of brass, and having no intercourse with each other, in what a miserable situation should we be! Instead of 2,300,000, London could not under such circumstances contain 30,000 inhabitants; and these would be exposed to the danger of an interruption in the supply of the necessaries of life. Unless the territorial division of labour were carried out to some extent, the division of employments amongst inhabitants of the same district could be but very imperfectly established, and would be of comparatively little use. It is only when one is able both to gratify his taste and to avail himself of the varying capacities of production given to different districts that the benefits of commerce can be fully appreciated, and that commerce becomes the most copious source of wealth as well as the most powerful engine of civilisation.

II. *Foreign Trade.*—The trade carried on between individuals of different countries is founded on precisely the same circumstances—the differences of soil, climate, and productions—on which is founded the trade between different districts of the same country. One country, like one district, is peculiarly fitted for the growth of corn; another for the cultivation of the grape; a third abounds in minerals; a fourth has inexhaustible forests. Providence, by thus distributing the various articles suitable for the accommodation and comfort of man in different countries, has evidently provided for their mutual intercourse. In this respect, indeed, foreign trade is of far more importance than the home trade. There is infinitely less difference between the products of the various districts of the most extensive country, than there is between the products of different and distant countries; and the establishment of a territorial division of labour amongst the latter must therefore be proportionally advantageous.

But to enable the advantages of foreign commerce to be rightly appreciated, it will be proper to consider it under the following heads: viz. 1. Its influence in supplying us with useful and desirable articles, of which we should otherwise be wholly destitute; 2. Its influence in multiplying and cheapening the peculiar productions of our own country; 3. Its influence in making us acquainted with foreign discoveries and inventions, and in exciting invention by means of competition and example: and, 4. Its indirect influence upon industry, by increasing the sources of enjoyment.

1. With respect to the first of these influences, or the effect of commerce in furnishing every people with commodities not otherwise attainable, it is too obvious and striking to require any lengthened illustrations. Great Britain is as abundantly supplied with native products as most countries; and yet anyone who reflects for a moment on the nature and variety of the articles we import from abroad, must be satisfied that we are indebted to trade for a very large part of our superior accommodations. Tea, sugar, coffee, wine, and spices; silk and cotton, the materials of our most extensive manufactures; gold and silver; and an endless variety of other highly important articles, are sent to us by foreigners. And were their importation put an end to, what a prodigious deduction would be made, not from our comforts and enjoyments merely, but also from our means of supporting and employing labourers! If foreign commerce did nothing more than supply us with so many new products, it would be very difficult to overrate its value and importance.

2. But such is the beneficent influence of commerce, that while it supplies an endless variety of new productions, it multiplies and cheapens those that are peculiar to every country. It does this, by enabling each separate people to employ themselves, in preference, in those departments in which they enjoy some

natural or acquired advantage, and by opening the markets of the world to their productions. This principle holds universally. The most important manufacture, at least till recently, carried on in Great Britain—that of cotton—is entirely the result of commerce. Supposing, however, that cotton wool had been a native product, we could never have made such astonishing advances in the manufacture if we had been denied access to foreign markets. Notwithstanding the splendid discoveries in the machinery, and the perfection to which every department of the trade has been brought, the vast extent of the market has prevented its being glutted, and has stimulated our manufacturers and artisans to persevere with unabated ardour in the career of improvement. Our cotton mills have been constructed, not that they might supply the limited demand of Great Britain, but that they might supply the demand of the whole world. And in consequence of the extraordinary subdivision of labour, and the scope given to the employment and improvement of machinery by the unlimited extent of the market, the price of cottons has been reduced to less, probably, than a fourth part of what it would have been had they met with no outlet in foreign countries. The hardware, woollen, leather, and other manufactures, exhibit similar results. The access which their products have had to other markets has led to important improvements in their production; so that, as was previously stated, commerce not only supplies us with a vast variety of new and desirable articles, but it also cheapens the staple productions of the country, and renders them more easily attainable by the great mass of people.

3. The influence of commerce in making the people of each country acquainted with foreign inventions and discoveries, and in stimulating ingenuity by bringing them into competition with strangers, is obvious and powerful. It distributes the gifts of science and art, as well as those of nature. It is the great engine by which the blessings of civilisation are diffused throughout the world, the intercourse to which it gives rise making everyone acquainted with the processes carried on and the inventions made in the remotest corners of the globe. Were any considerable improvement made in any important art either in China or Peru, it would be very speedily understood and practised in England. It is no longer possible to monopolise an invention. The intimate communication that now exists amongst nations renders any important discovery, wherever it may be made, a common benefit. The ingenious machine invented by Mr. Whitney, of the United States, for separating cotton wool from the pod, has been quite as advantageous to us as to the Americans; and the inventions of Watt and Arkwright have added to the comforts of the inhabitants of Siberia and Brazil, as well as of England. The genuine commercial spirit is destructive of all sorts of monopolies. It enables every separate country to profit by the peculiar natural powers and acquired skill of all the others; while, on the other hand, it communicates to them whatever advantages it may enjoy. Every nation is thus intimately associated with its neighbours. Their products, their arts, and their sciences, are reciprocally communicated; and the emulation that is thus excited and kept up forces routine to give place to invention, and inspires every people with zeal to undertake, and perseverance to overcome, the most formidable tasks. It is not possible to form any accurate notions as to what would have been our state at this moment, had we been confined within our own little world, and deprived of all intercourse with foreigners. We know, however, that the most important arts, such as printing, glass-making, paper-making, &c., have been imported from abroad. No doubt we *might* have invented some of these ourselves; but there is not the shadow of a ground for supposing that we should have invented them all; and without foreign example and competition, we could hardly have carried any of them beyond the merest rudiments.

4. The influence of commerce upon industry, by its increasing the number of desirable articles, though not quite so obvious, perhaps, as the influences already specified, is not less powerful and salutary. Industry is in no respect different from the other virtues, and it were idle to expect it should be strongly manifested where it does not bring along with it a corresponding reward. In the early stages of society, before artificial wants have been introduced, and men are satisfied if they can avert the attacks of hunger, and procure an inadequate defence against the cold, industry is confined within the narrowest limits; and if the mildness of the climate renders clothing and lodging of little importance, and the earth spontaneously pours forth an abundant supply of fruits, the inhabitants are immersed in sloth, and seem to place their highest enjoyment in being free from occupation. Sir William Temple, Mr. Hume, and some other sagacious enquirers into the progress of society, have been struck with this circumstance, and have justly remarked that those nations which have laboured under the greatest national disadvantages have made the most rapid advances in industry.

But in civilised and commercial societies, new products and new modes of enjoyment, brought from abroad, or invented at home, stimulate the inhabitants to continued exertions. Their acquired tastes and the wants which civilisation introduces, and custom and example render universal, become infinitely more numerous, and as urgent as the tastes or wants of those that are less advanced. The passion for luxuries, conveniences, and enjoyments, when once excited, becomes quite illimitable. The gratification of one desire leads immediately to the formation of another. Hence the true way to render a people industrious is to endeavour to inspire them with a taste for the luxuries and enjoyments of civilised

life; and this will be always most easily done by giving every facility to the cultivation of foreign commerce. The number of new articles, or, in other words, of new motives to stimulate, and new products with which to reward the patient hand of industry, is then prodigiously augmented. The home producers exert themselves to increase their supplies of disposable articles, that they may exchange them for those of other countries and climates; and the merchant, finding a ready demand for such articles, is stimulated to import a greater variety, to find out cheaper markets, and by anticipating wants to supply incentives to the industry of consumers. Every power of the mind and body is thus called into action; and the passion for foreign commodities—a passion which some shallow moralists have ignorantly censured—becomes one of the most efficient causes of industry, wealth, and civilisation.

III. *Colony Trade.*—For some remarks on this head, the reader is referred to the article COLONY.

Principle and Influence of Restrictions on Commerce.—The commercial intercourse carried on between the inhabitants of different districts of the same country, and those of different countries, is founded on the principle which prompts each member of the same family, or each inhabitant of the same village, to apply himself to some one business. It would therefore seem that that *freedom* of commerce which is universally admitted to be productive of the most beneficial consequences when established between the occupants of different districts of the same country, must be equally beneficial when established between those of different countries. It appears to be generally believed, that to occasion a commercial intercourse, nothing more is necessary than to remove such legal or physical obstacles as may interpose to prevent it. But this is not by any means enough. A of Yorkshire does not sell to or buy from B of Kent, merely because there is nothing to hinder him from doing so; he must further believe that his interest will be promoted by the transaction: unless he do this, the utmost facility of exchanging will be offered to him in vain; nor will the finest roads or the speediest conveyances occasion the least intercourse. We neither buy nor sell for the mere pleasure of the thing. We do so only when we believe it will be a means of promoting some end, of procuring some peculiar advantage for ourselves that we could not so easily procure in any other way. If anyone supposed he could better attain his object in entering upon a commercial transaction with some particular individual by entering upon a similar transaction with some one else, or by any other means, he would most certainly decline engaging in it. We may, and often do, make a false estimate of what is for our advantage; but its promotion is the mainspring of our actions; and it is this, and this only, that we have in view when we buy of a particular individual, or resort to a particular market, in preference to others.

Unless, therefore, it could be satisfactorily established that princes and rulers understand better than their subjects what has a tendency to promote the wealth and industry of the latter, it is difficult to see on what ground any restriction on the freedom of commerce is to be vindicated. The person who buys French wine or Polish corn, does so only that he may benefit himself; and the fair presumption is that he does what is right. Human reason is, no doubt, limited and fallible; we are often swayed by prejudice, and are apt to be deceived by appearances. Still, however, it is certain that the desire to promote our own purposes contributes far more than anything else to render us clear-sighted and sagacious. 'Nul sentiment dans l'homme,' says M. Say, 'ne tient son intelligence éveillée autant que l'intérêt personnel. Il donne de l'esprit aux plus simples.' The principle that individuals are, speaking generally, the best judges of what is most beneficial for themselves, is universally admitted to be the only one that can be safely acted upon. No writer of authority has lately ventured to maintain the exploded and untenable doctrine, that governments may advantageously interfere to regulate the pursuits of their subjects. It is their duty to preserve order, to prevent one from injuring another; to maintain, in short, the equal rights and privileges of all. But it is not possible for them to go one step farther, without receding from the principle of non-interference, and laying themselves open to the charge of acting partially by some, and unjustly by others.

'The statesman,' says Adam Smith, 'who should attempt to direct private people in what manner they ought to employ their capitals, would not only load himself with a most unnecessary attention, but assume an authority which could safely be trusted not only to no single person, but to no council or senate whatever, and which would nowhere be so dangerous as in the hands of a man who had folly and presumption enough to fancy himself fit to exercise it.' (*Wealth of Nations* p. 200.)

In every discussion as to any point of public economy, it is essential to bear in mind that the legislature abandons its duty, or rather acts in direct opposition to it, the moment it begins to legislate in the view of promoting the interest of particular classes. The question never ought to be whether any proposed measure or regulation has a tendency to benefit agriculturists, manufacturers, or merchants; but whether its tendency be to benefit the public. Certain individuals or classes may be benefited by what is prejudicial to others; but it would be a contradiction to contend that a system of policy which enriches A by impoverishing B can be publicly advantageous; and it is upon this latter consideration that the attention of the legislature should always be

fixed. Whatever has any tendency to increase the security of property, to perfect the divisions of labour, to stimulate industry and ingenuity, and to increase the wealth and comforts of *all* classes, deserves the encouragement of government. But when it goes farther, and interferes to prohibit individuals from carrying on certain branches of trade that others may be promoted, it arrogates to itself that authority the assumption of which is so justly censured by Adam Smith. Such prohibition is, in fact, quite subversive of the right of private property; for that right is violated, not merely when a man is unjustly deprived of any part of his fortune, but also when he is prevented from disposing of it in any way, not hurtful to others, he may think fit. We may safely leave the conduct of individuals to be determined by their own prudence and sagacity. They act under the most serious responsibility; and we have the best attainable security, the plain and obvious interest of the parties, that they will, in the peculiar circumstances under which they are placed, follow that course which is most advantageous for themselves, or, in other words, for the community.

We cannot, however, feel any surprise that these principles should have been so widely departed from, and that commerce, and indeed most sorts of industry, should have been everywhere subjected to restrictions and regulations. These restrictive laws originated in a comparatively unenlightened age, before the genuine sources of public wealth and the limits of proper interference on the part of governments had been explored and defined. The fallacies on which most of them are founded, however obvious they may now seem, were not speedily or easily detected; and, after their hollowness has been exposed, the return to a better system is a work of extreme difficulty. Every regulation affecting the employment of capital and industry, though always injurious to the public, is, for the most part, productive of advantage to a greater or smaller number of individuals. The moment that any change is proposed, these persons lay before government the most exaggerated representations of the injury that would result from the abolition or modification of the regulation; and not satisfied with this, they most commonly enlist a portion of the press into their service, and availing themselves of all the aid that sophistry and ingenuity can supply, labour to make the public believe that the regulation complained of is a national benefit, and that they are interested in its support! This device has very often been attended with the most complete success; and it is to this circumstance, more than to anything else, that the tenacity with which erroneous theories in commerce are supported is to be ascribed, and that sophisms, after having been again and again exposed, are put forward anew with as much seeming confidence as if they had never been questioned.

The measure of the commerce of this country is supplied by the returns of the declared value of all exports and imports. We have annexed to the foot of this article an account of the annual value of such commodities from January 1858 to the end of September 1864.

For a long time it was imagined that the test of a nation's commercial prosperity was to be found in the excess of the export value of its trade. This fancy, part of the mercantile theory exploded by Adam Smith, was derived from the notion, that in countries which did not produce the precious metals, or which did not produce them in any quantity commensurate with the wants of the country, the necessary supply could only be effected by a permanent excess in the value of exports. For the causes which regulate the distribution of the precious metals, in so far as they are used as a measure of value, the reader is referred to the article MONEY. At present it is sufficient to say, that there is no article of commerce which is so little affected by any statutory regulation as the precious metals. In the worst ages of legislative interference with the freedom of commerce, traders in these commodities were easily able to avoid any prohibition of the export of gold and silver; and at the present time the distribution of these products is governed by laws which fulfil the conditions of scientific exactness with absolute regularity; every country holding just as much of the precious metals as it needs for the purposes of trade, and no more.

The difference between the value of exports and imports (some elements, as the cost of transit and the variation in the rate of exchange, being taken into account) represents, as far as 'declared real values' can represent a value, the profit of the trade. The exports of a country pay for its imports, and the schedules of the two are as exact a statement of the commerce of the country, on the hypothesis that the returns can be relied on, as the 'profit and loss' account of a trading company indicates the available assets for dividend to shareholders. If, therefore, the real value of the exports equalled or exceeded that of the imports, the business would be carried on at a loss.

One caution, however, should be given in the interpretation of these returns, and this quite independently of their presumed exactness. They do not (as they are assumed to do) indicate any necessary connection between magnitude on the one side and *general* prosperity on the other. It is too commonly the case that politicians call attention to the growth of this commercial balance-sheet of the nation as designating great national wealth. But no small part of the increase may be assigned, first, to the great growth of English shipping; and next, to the fact that, by being the first to set her tariffs and mercantile system on a sound and sensible basis, Great Britain is becoming more and more a universal entrepôt for produce; in other words, an open market for all nations.

Real Value of the Total Imports and Exports of Merchandise, distinguishing British, Foreign and Colonial Produce (000'*s omitted*).

	1858	1859	1860	1861	1862	1863	1864 First 8 Months
Imports:	£	£	£	£	£	£	
Foreign . . .	125,969	139,708	167,571	164,809	160,434	164,235	
Colonial . . .	38,615	39,474	42,960	52,676	65,283	84,684	
Total . .	164,584	179,182	210,531	217,485	225,717	248,919	176,265
Exports:							First 9 Months
Great Britain and Ireland . . .	116,609	130,412	135,891	125,103	123,992	146,602	123,404
Foreign and Colonial	23,174	25,281	28,630	34,530	42,176	50,300	
Total . .	139,783	155,693	164,521	159,633	166,188	196,902	

The above Table does not include Exports and Imports of Gold and Silver Bullion and Coin.

Commissariat (Fr.). That department of an army whose duties consist in supplying provisions, forage, camp equipage, &c. to the troops. Every army on active service has its own commissariat, under a commissary-general. Abroad, our commissariat officers act as military accountants.

Commissary (Fr. commissaire). Is used in various ways as nearly synonymous with *deputy*. In the Army, the officers of the commissariat department are styled *commissaries*. In Ecclesiastical Law, an officer of the bishop intrusted with the performance of duties in the bishop's absence or in remote parts of the diocese is so called.

Commission (Lat. commissio). In the Army. The warrant authorising an officer to exercise command in the army is called his *commission*. Commissions in the Artillery and Engineers are given in the first instance to cadets from Woolwich [CADET], and in the higher ranks by seniority without purchase. In the Guards and Line commissions are given with or without purchase, as vacancies occur by an officer's selling out or by death. Until lately the sovereign signed all commissions; but an Act was passed a short time ago dispensing with the royal signature. The prices of commissions appear in the *Army List*.

COMMISSION. In Law. An appointment, usually by warrant or letters patent to one or more as commissioners, to perform certain duties specified in the instrument. In this mode many of the highest judicial or ministerial functionaries of the realm are appointed; thus, the judges of the superior courts hold several commissions, as of oyer and terminer, gaol delivery, &c. High offices of state, when not regularly filled, are often intrusted to commissioners for the time being, and said to be put in commission; thus the custody of the great seal is put in commission in the absence of a lord chancellor and lord keeper. The Treasury and Admiralty have of late times been usually intrusted to commissioners, no lord high treasurer or lord high admiral having been appointed. The Court of High Commission consisted of persons appointed under letters patent to examine into matters of ecclesiastical jurisdiction, under stat. 1 Eliz. c. 1 (abolished 16 Ch. I.). Magistrates or justices of the peace are appointed by means of a commission, occasionally renewed, commonly termed the *commission of the peace*.

COMMISSION. In the Navy. The title of the appointment or warrant of officers of the rank of lieutenant and above to hold their office. The commission is signed by the lords commissioners of the Admiralty.

Commissures (Lat.). A term applied in Anatomy to certain parts of the brain which cross from one of its sides to the other. [BRAIN.]

COMMISSURÆ. In Botany, this term signifies the place of junction of two opposite carpels.

Commitment (from Lat. committo). In Law, the sending to prison of one charged with any crime. It appears to have been the ancient usage that whoever could lawfully arrest a person for felony or treason could also send or bring him to the common gaol; but since the Habeas Corpus Act it is the uniform practice that offenders are committed by the warrant in writing of a justice of the peace. The privy council and secretary of state can also commit in cases of treason. A commitment in writing must declare the authority of him who makes it, and also the nature of the offence with which the party is charged.

Committee. In the language of Parliament, is either a committee of certain members, or a committee of the whole house. [PARLIAMENT.] *Select committees* are bodies appointed by open nomination or by a peculiar mode of election for the transaction of business, either according to the standing orders, by Act of Parliament, as in the case of election committees, or by accustomed usage. All private bills are referred in the first instance to select committees. *Joint committees* in former times consisted of bodies deputed by the two houses, which met for the purpose of adjusting differences, sometimes after free conferences had failed. They were free from the forms observed in conferences.

As in the latter, the Lords deputed only half the number of members sent by the Commons. They have been long disused.

Commodore (Port. commendadôr, *a commander*). The senior captain of a squadron, when there is no admiral present.

Common (Lat. communis). In Law, is the right which one person has of taking a part of the produce of land, while the whole property in the land is vested in another. Common of pasture is either, 1. *Common appendant*, which is the right of the tenant of a manor to pasture his beasts on the lord's waste; 2. *Common appurtenant*, annexed to land by grant or prescription; 3. *Common in gross*, a right severed from the land.

When a common is under pasture, all those who have a right of pasturage may turn out on it a certain number of animals, according to the extent of the enclosed grounds which they cultivate. When the common consists wholly or partly of arable land, this arable land is formed into ridges, generally with a narrow riband or balk of turf between each ridge, or between each two or three ridges. The right of cultivating these ridges is distributed among the holders of the enclosed lands of the parish, according to the extent of their possessions; and in order that there may be no partiality, and that everyone may have as much interest in preserving his neighbour's ridge as his own, the ridges which any individual has the right of cultivating do not lie together, but are distributed among the ridges of his neighbours. Enclosure of commons is usually effected by local Acts of Parliament; regulated, however, by the provisions of the general enclosure Acts 41 Geo. III. c. 109 and 1 & 2 Geo. IV. c. 23.

Common Measure. In Mathematics, a quantity which is contained an exact number of times in each of two or more given quantities. [COMMENSURABLE.]

Common Pleas or **Common Bench, Court of.** In Law, was originally that branch or side of the *aula regia* in which civil causes between subjects were tried. It was separated and rendered stationary, while that portion of the court from which the King's Bench is derived followed the person of the king by a provision of Magna Charta. This court has concurrent jurisdiction with the other two superior common law courts [COURTS, SUPERIOR] in personal actions and ejectments. But it retains exclusive jurisdiction over all other mixed, and all real actions or pleas of land. These, however, have now nearly fallen into disuse. [PLEADING.] The Court of Common Pleas has one chief and four puisné judges.

Common Prayer Book. The name given to the collection of all the offices of regular and occasional worship according to the forms of the church of England. The basis of this book is to be found in the King's Primer, set forth in 1546 by Henry VIII., which was intended to convey instruction to the people in the most important parts of the church service; but contained little more than the Creed, Lord's Prayer, Commandments, and Litany. This Primer underwent two revisions and republications under Edward VI., whose second Liturgy approaches very near in its contents to that which exists at present. It was at that review that the Sentences, Exhortation, Confession, and Absolution were prefixed to the Daily Service; the Decalogue was introduced into the Communion Service; and certain remnants of the Romish customs were finally abolished, as the sign of the cross in confirmation and matrimony, the anointing of the sick, and the prayers for the dead.

On the accession of Elizabeth, another review of the Liturgy was instituted; but the alterations effected were little more than in the selection of the Lessons. At the review in the reign of James I., after the conference with the Presbyterians at Hampton Court, no change of importance was introduced, except the addition of the explanation of the Sacraments in the Catechism. Again, when on the restoration of Charles II. a conference had been held with the Dissenters at the Savoy, the subject of the Common Prayer Book was reconsidered in convocation. The services for the 30th of January and 29th of May were then added, as also the Form to be used at Sea. A few trifling alterations were made also in the other services; but these were the last that have been effected. On the accession of William III. another revision took place, and a considerable number of alterations were proposed and supported by many of the bishops and clergy; but they were rejected by convocation, and have never since been revived by authority. The following is a chronological list of the revisions of the Prayer Book in which any alterations have taken place:—

1546. The King's Primer.
1548. The Communion Service.
1549. First Liturgy of Edward VI.
1550. First Ordination Service.
1552. Second Liturgy of Edward VI.
1552. Second Ordination Service.
1560. Liturgy of Elizabeth.
1604. Alterations introduced by James I.
1633. Alterations introduced by Charles I.
1661. Last Revision; authorised Liturgy.

Lastly, the occasional or political services have been recently abolished by Act of Parliament.

Common Salt. [ROCK SALT.]

Common Time. In Music, that in which every measure or bar contains an even number of subdivisions, such, for example, as two minims, four crotchets, eight quavers, and so on.

Commons, House of. [PARLIAMENT.]

Commonwealth. [REPUBLIC.]

Commonwealth of England. In History, the form of government established in England on the death of Charles I. in 1649, and which existed during the protectorate of Oliver Cromwell and his son Richard, until the abdication of the latter in 1659. The substitution of a democratical for a monarchical form of government was provided for and

enjoined by two successive charters. The first charter of the commonwealth was drawn up, in December 1653, by the *council of officers*, who, on the voluntary resignation of the parliament in the early part of the same year, had declared Cromwell 'Protector;' it was styled the 'Instrument of Government.' The second charter, called the 'Petition and Advice,' was framed, in May 1657, by the parliament which the Protector had assembled in the previous year. Under the first charter, as has been well observed, the English government may be classed among republics with a chief magistrate at its head; under the second, it became substantially a monarchy, and Oliver Cromwell from 1657 to the period of his death was de facto king of England. On the demise of Cromwell, the succession of his son Richard was at first cordially recognised; but soon afterwards discontents and cabals having sprung up in the country, his inability or disinclination to govern induced him to abandon the protectorship after eight months; and on the 29th of May, 1659, the restoration of the monarchy under the old régime was effected by the triumphal entry into London of Charles II. For the character of Cromwell's government and foreign policy, see Hallam's *Constitutional History*, chap. x.

Communion, Holy. In Ecclesiastical History, a name given to the sacrament of the Eucharist, from the language of St. Paul, 1 Cor. x. 16.

Communism. [Right of Property and Saint Simonians.]

Commutants (Lat. commuto, *I exchange*). Functions which include determinants, but are less general than permutants. Their formation will be best illustrated by an example. Let (123), (132) &c. be symbols of any quantities whatever, and take any group of three rows of indices, such as

1,2,3,4,
1,2,3,4,
1,2,3,4.

Permute the indices of all the rows except the first, in all possible ways, and from each of the new groups thus obtained, such as

1,2,3,4,
3,2,1,4,
2,4,3,1,

form the product of the symbols (132), (224), (313), (441) corresponding to the columns; prefixing, in each case, the sign compounded of the signs (+,−) due to the row-arrangements of each group [Rule of Signs]; the algebraical sum of all such products −(132)(224)(313)(441) will be the commutant, which may be said, in this example, to be of the fourth order and second class. A symbol for such a commutant would be

$$\left\{\begin{matrix}1234\\1234\\1234\end{matrix}\right\},$$

and a commutant of the first class would be clearly a determinant. [Determinant.]

We may add that a commutant of the n^{th} order and m^{th} class consists, in general, of a sum of $(\underline{n\rvert})^m$ terms, each term being a product of n factors or constituents. Thus in the above example, we should have $(1\times2\times3\times4)^2 = 576$ terms, each consisting of four factors. Further details on commutants will be found in papers by Cayley and Sylvester published in the *Cambridge and Dublin Mathematical Journal*.

Commutation. In Astronomy, the angle of commutation of a planet is the angle formed at the earth by a straight line drawn from the earth to the sun, and the orthographic projection on the plane of the ecliptic of the straight line which joins the earth with the planet. It is measured by the difference between the sun's longitude and the geocentric longitude of the planet.

Commutation of Tithes. [Tithes.]

Comose. Ending in a tuft or kind of brush.

Companion. The head or covering over a ladder (or staircase) in a ship; but the name is commonly applied to the ladder itself.

Company (Fr. compagnie). In its most general sense, means any two or more individuals associated for any common object, whether of business or pleasure.

In its more limited sense, however, and that in which it is usually understood in this country, the term *company* means an association of individuals for the prosecution of some industrial undertaking. Such associations may be of very various descriptions, inasmuch as the terms of the association or partnership may be varied in an infinity of ways. Generally, however, they may be said to be either *private* or *public* companies; that is, according to the law of England, companies with not more than six partners and with more than six; and public companies may farther be divided into *joint-stock* and *regulated* companies, and these again into *incorporated* and *unincorporated* companies, or into companies without and with the *unlimited liability* of the partners.

I. The principle on which associations for industrial purposes are established is too obvious to require much illustration. All great results are brought about by cooperation, and could not be effected otherwise. Isolated man is comparatively feeble and helpless; the capacity of associating for a common purpose is, in fact, the main source of his power and the principal distinction between him and the lower animals. One man has capital without skill, and another skill without capital; if such persons act independently, they will be able to effect little or nothing; but if they combine their efforts, and the capital of the one be applied and directed by the skill of the other, the effect of their exertions will be incomparably greater. But this is not all. Many of the greatest and most important works undertaken in modern times could not have been attempted by one individual, how opulent or skilful soever. It is to the voluntary association of individuals, for the purpose of commercial profit, that we owe these stupendous creations of modern art and science, which far exceed the most re-

nowned works of the wealthiest princes of antiquity. These great partnerships, only possible where property is secured by the just and equal administration of law, are characteristic of modern civilisation. They were virtually unknown to the economy of Greece and Rome, for the associations entered into in these communities seldom negotiated anything beyond the collection of taxes. The principle, however, on which companies are formed, can be traced to the action of the Italian merchants during the later part of what are called the middle ages, and in these to the formation of joint-stock banking companies.

In our own country they commence with the trading companies of merchant adventurers, created out of the stimulus given to trade by the simultaneous discovery of the New World and the Cape passage, and the diversion of traffic from the trading towns of Italy, by the adoption of long sea-voyages. Since this epoch, one of these companies has founded and consolidated a vast empire, while another has exercised a delegated sovereignty over the greater part of the North American continent. Or, to advert to agencies of more unquestionable public utility, we owe to the joint-stock principle the banks, the roads, the canals, the railways, and other similar gigantic undertakings, which, by receiving and aggregating small fragments of capital, have rendered such vast services to the industrial energies of mankind. Nevertheless, great as have been hitherto the effects of this principle, we shall find, in all probability, that they are comparatively speaking as nothing by the side of results to be hereafter achieved by the extension and adaptation of voluntary associations for trading purposes.

II. In *private* companies the business is usually conducted by one or more of the partners on the principles laid down in the deed of partnership. The rights and obligations of the partners as respects each other are, of course, mainly determined by this deed: as respects the public, the law regards the act of one partner as the act of the company: and each partner is bound, without any regard to the sum he has subscribed to the company's stock, to the whole extent of his fortune, for the debts and engagements of the firm. Certain formalities are necessary at the withdrawal of a partner; such as advertising in the *Gazette*, and the sending of special information of the fact to all individuals in the habit of dealing with the company. [PARTNERSHIP.]

III. *Public* companies may, as already stated, be either joint-stock or regulated; and these again may be either incorporated or unincorporated.

1. By a joint-stock company is meant a company the stock of which is subscribed by a certain number of persons in shares of a certain amount. Thus, supposing that a joint-stock association is to be formed for carrying on the business of banking or insurance, for excavating a dock or a canal, or for constructing a railway, and that its capital is to amount to 1,000,000*l.* to be subscribed in shares of 100*l.* each; any individual (unless exceptions be made in the conditions under which the company is to be formed) who can command 100*l.* may become a partner of this association, and will be registered in the company's books as the holder of a share of 100*l.* of the company's stock. It is customary, too, in the vast majority of instances, to allow individuals to transfer their stock or shares to others, who succeed to all the rights and obligations of their predecessors; though in some cases the vendor's liability is continued for a considerable time after he has transferred his shares or stock. The price which shares or portions of stock fetch in the market depends, of course, on the real or supposed state of the company's affairs: if it be known or supposed to be in a flourishing and prosperous condition, and paying a high interest or dividend on its stock, the latter may sell for 10, 20, 50, or 100 per cent. or upwards of advance; whereas if it be known or supposed to be in an unprosperous condition, its shares may not bring a third or a tenth part of what they originally cost.

The affairs of companies of this description are usually conducted by salaried officers, who are appointed by and act under the orders of a board of directors chosen by the company at large, according to the conditions in their deed of association. The partners in such companies are all individually liable, without regard to the magnitude of their stock or shares, for the entire debts and obligations of the company.

At common law no action can be raised by or against such companies without making all the shareholders parties to the action. But the obvious and insuperable inconveniences that would result from the enforcement of this rule led to the enactment, 1 Vict. cap. 73, that the crown may at pleasure grant to joint-stock associations letters patent, authorising them to sue and be sued in the names of particular officers of their own: without, however, unless government judge proper, incorporating the company, or affecting the liability of the different partners for its debts.

2. When joint-stock companies are incorporated by royal charter, or by letters patent, the liability of the partners is limited to the amount of their stock, and they cease to be responsible beyond that amount. This is the case with some great joint-stock associations (as the banks of England, Scotland, and Ireland), and many of the insurance companies. In the earliest of these joint-stock companies the privileges granted by charter were obtained in consideration of large sums of money paid to government, or lent at low rates of interest. This was particularly the case with the Bank of England.

The grand distinction between unincorporated and incorporated joint-stock companies is, that in the case of the former the law looks only to the individuals forming the association; while

in the latter it looks only to the corporate body, and pays no attention to the individuals of which it is made up. On judgment against an incorporation, execution can only pass on the corporate property; and supposing it to become insolvent, the partners can only, as already stated, be called upon to make good the amount of the stock of the incorporation standing in their names. But it is quite otherwise with an unincorporated joint-stock company: should it become insolvent, the partners, to use the words of Lord Eldon, are severally liable for the whole debts and engagements of the company, even '*to their last shilling and their last acre.*'

3. *Companies with limited liability.* Latterly, however, it has been deemed of importance to lessen this unlimited responsibility now referred to, and very great facilities have in consequence been given for the formation of companies on the principle of *limited liability.* They may now be introduced into most of the industrial departments; and various statutes have been passed defining the proceedings necessary to be followed in constituting companies so as to insure the limitation of the liabilities of the partners. These companies have many points in common with what the French call *sociétés en commandite,* in which the *gérant,* or manager, is alone responsible to the extent of his means, the other partners, or *commanditaires,* being responsible only for the amount of their shares.

Great difference of opinion has prevailed as to the prudence of permitting the formation of such companies. The principle, however, has been so far approved by public opinion, as to make the question practically unimportant, though it may be well to say a few words as to the grounds of objection taken, and to the arguments in favour of the system.

The chief objection to the principle of limited liability is, that it encourages fraud by diminishing responsibility. It is held that, when the liability is absolute, there is a great check to rash and *protected* speculation. And it has been alleged, with some show of reason, that the fact of joint-stock banks declining, with very few exceptions, to avail themselves of the power of rendering their shareholders liable for the amount of their shares only, is a conclusive proof that the principle is unsound; because these trading companies, whose reputation cannot be trifled with or suspected, are averse to the protection which they can assume.

But, on the other hand, it is answered that partners may find it advantageous to trade on unlimited liability, without it being at all necessary that efficient guarantees should be taken for the soundness of their operations. In point of fact, the worst cases of commercial fraud are those in which the dictum of Lord Eldon, quoted above, has applied in theory but failed in practice, because the acre and the shilling have been pledged and spent before the crash occurs. Nay, we may go farther, and say that the principle of unlimited liability may, in banking operations at least, produce what is practically an imperial guarantee. It is possible to conceive a bank, whose subscribed capital is large, but whose liabilities on deposit and on commercial bills may be many times over the amount of its capital. The management of such a bank may be generally excellent, and the supervision exercised by its directors unwearying. But it may, even though not injured by any fraud, become the object of a commercial panic, and if its liabilities were, as has been suggested, great, even if its assets be based on excellent securities, it may be so affected as to require some strong external support for its preservation during a crisis, and in order to avoid a great national disaster, procure aid from government. And it may be alleged that, if its liability were limited, its business would be safer because more circumscribed.

In point of fact, all joint-stock companies share the weakness more or less inherent in business concerns where the manager has only a slight share in the profits of the undertaking. Such delegated management would be at all times and naturally less cautious, less anxious, more speculative, more unthrifty, than a business which formed the sole interest of an individual. To determine whether unlimited or limited liability is the safer for the public or the shareholders is not perhaps at present possible, but the trial which has been given to the system is by no means unfavourable to the principle, and in no way justifies the forebodings which have been uttered as to the risks attending limited liability.

It has been urged that the same privilege should be extended to private partnerships; and as public opinion is decidedly favourable to the system, it will not probably be long before it will be accepted to this extent. There does not, indeed, seem any great difference between a loan from a capitalist to a trader, and an advance made by a banker to a beginner; and there is a suspicion that the opponents of the principle of limited liability are not so much influenced by anxiety for the public, as by a desire to check a practice which might enter into serious competition with the interests of ordinary traders.

3. *Regulated companies* consist of a number of unconnected individuals or associations engaged in the same business or department of trade, under condition of their conforming to regulations laid down for their common guidance. Such companies have been mostly formed for the prosecution of the trade with distant and peculiarly situated countries. Their principle is not to exclude individual competition, but merely to make the different parties engaged in the trade observe the same general rules. Companies of this description were at one time common; but they have now mostly fallen into desuetude, though it is easy to imagine circumstances in which they might be advantageously revived.

4. *Civic companies,* of which there are many in the city of London and other large towns, are in reality *guilds* or *fraternities.* Originally

they consisted of the parties carrying on a peculiar trade or profession; and in most instances they gradually acquired the privilege of prescribing the conditions and limitations under which individuals not belonging to the fraternity might obtain leave to engage in its peculiar trade within the precincts of the city or borough to which it belonged. In more modern times, however, the injurious influence of such restrictions on the free exercise of industry became obvious; and in consequence the powers formerly exercised by civic companies or guilds over individuals not free of their society, who attempted to carry on the same trade, have been either wholly repealed or greatly modified. At present, therefore, the companies in question exist principally as charitable institutions, or as incorporated associations, having, in many instances, the management of large amounts of property appropriated for the use of their poorer brethren, or for some similar purpose.

COMPANY. In the Army, a body of men, forming one of the chief divisions of a battalion of infantry. The establishment of a company is generally about 100, but it varies according to the requirements of the service, as determined at the War Office. A company is commanded by a captain, and has two subaltern officers attached to it.

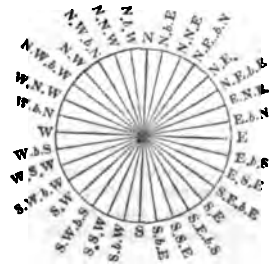
Comparative Grammar. [GRAMMAR; LANGUAGE.]

Comparison or Simile. In Rhetoric, appears to differ from METAPHOR [which see] only in form: the resemblance being stated in the first case, while it is implied in the second. This is the sense in which the term *comparison* is used and defined by Aristotle, in his *Art of Rhetoric.* Frequently the same idea furnishes at the same time both comparison and metaphor; as in the following line, 'They melted from the field as snow.' The word *melted* is used by transferring the property of the snow to a multitude of individuals: so far, therefore, the phrase is a metaphor; but the additional words 'as snow,' transform it into a direct comparison. It will generally be found that in every language the earliest writers, especially the poets, are the most addicted to the use of comparisons and metaphors of a highly figurative and bold character, as is especially observable with respect to the poetry of the Old Testament, and to Homer; while as language advances in cultivation the metaphor comes more and more into ordinary use, and forms, as it were, the basis of composition, while at the same time it gradually loses the energetic and poetical cast which at first distinguished it.

Comparison, Degrees of. In Grammar. Inflexions of adjectives denoting the degree in which a quality is possessed by a substance, either generally or in reference to other substances. Although some systems of Grammar speak of three degrees of comparison, there are in strictness only two, the comparative and the superlative, of which the former compares two conceptions only, as 'John is *taller* than Charles.' The second compares one conception with any number of others, whether as denoting definite or general superiority.

Compass (Fr. compas, a word made up from Lat. con, and passus, *a step*). A name given to instruments contrived to indicate the magnetic meridian, or the position of objects with respect to that meridian. According to the purposes to which the instrument is chiefly applied, it becomes the *mariner's compass*, the *azimuth compass*, the *variation compass*, each particular application requiring some peculiarity of construction; but whatever modifications it may receive, the essential parts are the same in all cases. These are a magnetised bar of steel, called the *needle*, having (fitted to it at its centre) a cap, which is supported on an upright pivot, made sharp at the point in order to diminish the friction as much as possible and allow the needle to turn with the slightest force. The *mariner's compass* has a circular card attached to its needle, which turns with it, and on the circumference of which are marked the degrees, and also the 32 *points* or *rhumbs*, likewise divided into half and quarter points. The pivot rises from the centre of the bottom of a circular box, called the *compass box*, which contains the needle and its card, and which is covered with a glass top to prevent the needle from being disturbed by the agitation of the air. The compass box is suspended within a large box, by means of two concentric brass circles or gimbals; the outer one being fixed by horizontal pivots, both to the inner circle which carries the compass box, and also to the outer box, the two sets of axes being at right angles to each other. By means of this arrangement the inner circle, with the compass box, needle, and card, always retains a horizontal position notwithstanding the rolling of the ship.

The notation of the mariner's compass is as follows: The circumference being divided into the four quadrants by two diameters at right angles, the extremities of these diameters are the four cardinal points (cardo, *a hinge*), marked N., S., E., W. (north, south, east, west). Bisecting each of the quadrants, the several points of



bisection are denoted by placing the two letters at the extremities of the quadrant in juxtaposition. Thus, N.E. (north-east) denotes the point which is half-way between north and east; and so with N.W., S.E., S.W. (north-west, south-east, south-west). Let the octants

next be bisected; the points of division are denoted by prefixing to each of the above combinations first the one, and then the other of the two cardinal points of which it is formed. Thus N.E. gives N.N.E. and E.N.E. (north north-east, and east north-east); and so in respect of the others. Sixteen points have thus been named. Let the distances be again bisected; then each of the points so found is expressed by that one of the preceding points already named to which it is nearest, followed by the name of the cardinal point towards which its departure from the nearest points leads it, the two being separated by the letter *b* (by). Thus, the point half-way between N. and N.N.E. is N. by E. (north by east); that which is half-way between N.N.E. and N.E. is N.E. by N. (north-east by north), &c. The whole of the thirty-two points are thus distinguished, as in the figure.

The introduction of iron ships, and especially of iron-plated ships, has rendered the task of steering very difficult; for such vessels are themselves magnets, and the disturbance which they produce on the needle has required all the skill of our scientific men to overcome them. It has been found that the disturbance is least when the ship has been built with her head south and plated with her head north; thus the magnetism acquired during building is gradually diminished by the hammering attending the operation of plating. Frequent alterations of the first adjustments made are, however, necessary. For the process of adjustment, see SWINGING.

Like many other of the most valuable arts of life, the origin of the compass is entirely unknown. By some writers it is ascribed to Flavio Gioja, who lived in the thirteenth century; yet Guyot de Provence, who lived a century earlier, speaks of the loadstone, to which he gives the name of *marinetti*, or mariner's stone, as useful to navigation. The term *bussola* in Italian, and *boussole* in French, has also been supposed to be derived from our term *box*. It appears very probable that the Chinese were acquainted with the directive property of the loadstone at an early period. Their method is to place it on a small piece of cork and set it to float on water. The art of communicating the magnetic virtue to steel, and suspending the needle on a pivot, is undoubtedly a European invention.

The *azimuth compass*, being intended to show the bearing of objects in respect of the magnetic meridian, has its circle divided merely into degrees, instead of the rhumbs used in navigation, and is provided with sights to allow the angles to be taken more accurately.

The *variation compass* is designed to exhibit the diurnal changes in the deviation of the magnetic from the true meridian; and the needle is generally made of much greater length than in the mariner's compass, in order to render minute variations more sensible. [MAGNETISM.]

Compass of the Voice. In Physiology, is the number of notes of the musical scale comprehended in the voice of a singer; it usually extends from two to three octaves.

Compensation Pendulum. [PENDULUM.]

Compitalia (Lat. from compitum, *a street*). A Roman feast celebrated in honour of the Lares and Penates. Under Tarquinius Superbus, it is said that human victims were sacrificed at this solemnity. The gods invoked at it were termed *compitales*, as presiding over the streets.

Complement. In Mathematics, the complement of any magnitude is a second magnitude which, added to the first, gives a sum equal to a given third magnitude. This third magnitude is purely arbitrary and conventional. Thus the complement of an angle is its defect from a right angle. The complement of a common logarithm is its defect from 10; thus—

$$\text{comp. log } 2 = 10 - \cdot 30103 = 9\cdot 69897.$$

The arithmetical complement of a number is its defect from the next higher power of *ten*; thus—

$$\text{ar. comp. } 873 = 1000 - 873 = 127.$$

Euclid uses the term in a somewhat different sense in his theorems on parallelograms. A parallelogram being divided into four parallelograms by drawing parallels to its sides through any point of one of its diagonals, the two parallelograms which are not traversed by this diagonal are said to be the *complements* of the two which are.

COMPLEMENT OF A SHIP. Is the established number of officers and seamen of the several grades by whom she is intended to be manned.

Complementary Colours. In Optics, two colours are said to be complementary to each other, when they are such that the blending together of the two gives rise to the perception of whiteness. Thus the red and green colours of the prismatic spectrum give, when blended together, white light, as do also blue and orange.

Complex Numbers. [INTEGER.]

Compluvium (Lat.). In ancient Architecture, this word is applied to the area in the centre of Roman houses, so constructed that it might receive the waters from the roofs.

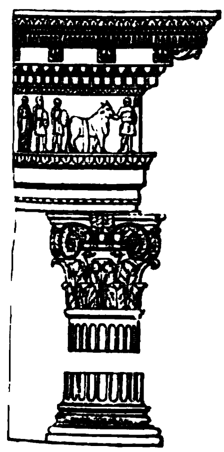
Composing (Lat. compono, *I place together*). In Printing, that branch of the art which consists in taking the types from the cases, and setting them up in such an order as to fit them for the press. The instrument in which they are set up and adjusted is called a *composing stick*, and the workman who arranges them a *compositor*. [PRINTING.]

Compositæ (Lat.). In Botany, the largest of all known natural groups of plants; and so called because the old botanists who invented the name regarded the flower-heads as compound flowers. They answer to the *Syngenesia Polygamia* of Linnæus, and are positively characterised by having capitate flowers, syngenesious anthers, and an inferior ovary with a single erect ovule. Lindley calls the order *Asteraceæ*, and computes the number of genera as exceeding

1,000, and of the species as over 9,000. They exist all over the world where vegetation can develope, and are sometimes trees, although more generally herbaceous plants or shrubs. Among medical species, the chamomile, wormwood, southernwood, elecampane, and opium lettuce are conspicuous; of esculents, the order contains the artichoke, the Jerusalem artichoke, the lettuce, succory, and endive; and among ornamental plants, the aster, dahlia, coreopsis, sunflower, &c. But by far the greater part of this large assemblage consists of species which are either weeds or of no known use. [ASTERACEÆ.]

Composite Number. A number which possesses one or more divisors besides unity and itself. Composite and prime numbers are opposed to each other in this respect.

Composite Order. This order of Architecture, as its name implies, is composed of two others, the Corinthian and the Ionic. Its capital is a vase with two tiers of acanthus leaves, like the Corinthian; but, instead of stalks, the shoots appear small, and adhere to the vase, bending round towards the middle of the face of the capital; the vase is terminated by a fillet, over which is an astragal crowned by an ovolo. The volutes roll themselves over the ovolo, to meet the tops of the upper row of leaves, whereon they seem to rest. The corners of the abacus are supported by an acanthus leaf bent upwards; and the abacus itself resembles that of the Corinthian capital. [CAPITAL.] In detail, the Composite is richer than the Corinthian, but it is less light and delicate in its proportions. Its architrave has only two fasciæ, and the cornice varies from the Corinthian in having double modillions. The column is ten diameters high. The principal ancient examples of this order are the temple of Bacchus at Rome, the arch of Septimius Severus, that of the Goldsmiths and that of Titus, and the baths of Diocletian. The example here given is from the arch of Titus. [ORDER.]



Composition. In the Fine Arts, that combination of the several parts, by which a subject is agreeably presented to the mind, each part being subordinate to the whole. [INVENTION.]

COMPOSITION. In Law, an agreement made between the owner of lands and the parson, with the consent of the ordinary and the patron, that such lands shall be discharged from the payment of tithes, by reason of some land or other real recompense given to the parson in satisfaction thereof. Such an agreement, since the 13 Eliz. c. 10, is not good for a longer term than three lives or twenty-one years. *Composition* signifies also the agreement between a bankrupt after his last examination and nine-tenths of his creditors for the satisfaction of their claims, and has the effect of superseding the fiat of bankruptcy.

COMPOSITION. In Music, the art of disposing and arranging musical sounds into airs, songs, &c., either in one or more parts, for voices or instruments or both. Zarlino defines it to be the art of joining and combining concords and discords, which are the matter of music.

Composition of Forces or Motion. In Mechanics, signifies combining or uniting several forces or motions, and determining the result of the whole. If a body is solicited by two forces which act in the same direction, the *resulting* force, or *resultant*, is equal to the sum of both; that is to say, the effect produced is the same as would be produced by a single force acting in the same direction, and equal to their sum. If the two forces act in opposite directions, the resultant is equal to their difference, and the body will move in the direction of the greater. If the lines of direction of the two forces make an angle with each other, the resultant will be a mean force in an intermediate direction. Thus, if the two forces be represented in intensity and direction by the two sides of a parallelogram, then the resultant is represented in intensity and direction by the diagonal of the parallelogram which passes through the angle formed by those two sides.

Composition and Resolution. [FORCES and ROTATIONS.]

Compositor. [COMPOSING; PRINTING.]

Compost. In Agriculture, a manure in which the dung of animals, or other organic matter, is mixed largely with earth, mould, lime, and other inorganic substances.

Compostella Hyacinth. Crystals of Quartz found at Compostella, and coloured red by an admixture of ferruginous clay.

Compostella, St. James of, or **St. James of the Sword.** An ancient order of knighthood in Spain, the chief of the four military orders (Compostella, Calatrava, Alcantara, Manresa); probably founded either by Alphonso IX. of Castile (1158, 1214), or Ferdinand II. of Leon (1157, 1188). It originally began from the voluntary association of certain gentlemen to defend the great road leading to the celebrated shrine of St. James at Compostella. Pope Alexander III. gave the order its rules of government. The order possessed at one period eighty-four commanderies, with two cities and numerous burghs and villages. The knights take the vows of poverty, obedience, and conjugal chastity; to which they add a fourth, 'to defend and maintain the immaculate conception of the Holy Mother of Jesus Christ.'

Compound Interest. Interest charged not only on the principal, but also on the

interest forborne. Thus, if money is invested so that the interest is not paid as it becomes due, but successively added to the capital, the capital is said to accumulate at compound interest. [INTEREST.]

Compressibility. The quality of bodies in virtue of which they can be reduced to small dimensions. All bodies, in consequence of the porosity of matter, are compressible, though liquids resist compression with immense force.

Compressor. In Artillery, a compressor is used in the service of heavy guns to check their recoil. It consists of an arrangement either for bolting down the rear of the carriage to the slide on which it recoils, or for jamming blocks attached to the carriage between the sides of the platform on which the carriage rests.

Comptonite. A variety of Thomsonite found in the lavas of Vesuvius, and named after Lord Compton.

Compurgation (from Lat. compurgo, *I purify*). An ancient mode of trial both in civil and criminal cases. In the latter, by the old English law (which William the Conqueror confirmed in this respect, at least as to its main features), the accused party was allowed to clear himself by the oath of as many of his neighbours to his innocence as amounted in collective worth, according to the legal arithmetic of the Anglo-Saxons, to one pound [WEREGILD], if he could in the first instance (being a villein) obtain the testimony of his lord that he had not been previously convicted. If otherwise, he was bound to undergo ordeal, or wage his law with a greater number of compurgators. Compurgation in criminal cases was abolished in general by Henry II.'s assizes, the ordeal being enforced in lieu of it. But it was retained as a special franchise in some boroughs, to which those assizes did not extend; and the last instances of it on record are to be found in the rolls of the hundred court of Winchilsea, in the reign of Henry VI. (Sir F. Palgrave *On the British Commonwealth*.) A singular usage of the same description long remained in the ecclesiastical courts, by which convicted clerks, allowed their clergy and delivered up to the ordinary, were admitted to purge themselves by the oaths of compurgators; it was abolished by 18 Eliz. c. 7. Wager of law, in civil cases, lay in some personal actions only, and in incidental traverses in real actions. (Blackstone, lib. iii. c. xxiii.)

Coms, Cooms, Coomes or **Chives.** The points of the radicles of malted grain, which after kiln-drying drop off during the process of turning. They are sold by maltsters under the name of *malt dust*, and are considered excellent manure.

Con Sordini (Ital.). In Music, a direction to perform the passage, if on a pianoforte, with the dampers down, or on a violin with the mute on; it is usually written short, C.S.

Conacre. A form of peasant occupancy once common in Ireland, though now rapidly becoming extinct. It consisted in the part or whole payment of wages by small grants of land, and closely resembled the allotment system prevalent in the times of the old poor law. It was worse, because even more precarious, than the cottier system, and it contributed with it to the social and economical degradation of the Irish peasantry. Experience generally seems to show, that unless the possession of land is extensive enough to supply subsistence at least to the occupier, and is durable enough to stimulate something more than a mere *annua cultura*, the possession of land by labourers is rather mischievous than beneficial.

Conarite (Gr. *κόναρος*, *an evergreen thorn-tree*). A greenish mineral found in small grains and crystals at Röttis in Voigtland.

Conarium (Gr. *κῶνος*, Lat. conus, *a cone*). A vascular membranous pyramidal sac continued from the third ventricle of the brain: the base expanding from between the anterior interspace of the optic lobes, and the apex directed forwards, and attached to the roof of the cranium.

Concave and **Convex.** A curve is said to be *concave* at a given point when the lines joining the latter to adjacent points fall between the spectator and the curve, and *convex* when the contrary takes place, that is to say when the curve is interposed between the spectator and the small chords in question. A surface is said to be *concave* or *convex* at any point, when the plane sections through that point and the spectator's eye are all concave or convex; when some of these sections present their concavity and others their convexity to the spectator, the surface is sometimes said to be *concavo-convex*. This is the case with the hyperboloid of one sheet or with a common dice-box. A mathematical test for concavity and convexity is easily found. When at a point on a curve the centre of curvature and the point of view fall on the same side of the tangent we have *concavity*, when on opposite sides *convexity*.

Concept (Lat. conceptus, part. of concipio, *I conceive*). In Logic, a term used to signify the result of the act or process of conception or mental representation, as distinguished from the process. [CONCEPTION.]

Conceptacle (Lat. conceptaculum, *a receiver*). A name applied to the capsular fruits of many cryptogamous plants. Thus it is given to a second form of fruit which occurs in the rose-coloured seaweeds distinct from tetrasperms; to certain organs in fungi containing both spores and their accessories; to the bodies which contain the reproductive organs of certain *Marsileaceæ*; and sometimes even to the cases containing the spores of ferns.

Conception (Lat. conceptio). In Mental Philosophy, that act of the mind by which we combine a number of individuals together by means of some mark or character common to them all. We may observe, for instance, that equilateral, isosceles and scalene triangles

all agree in one respect, that of having three sides; and from this perceived similitude we form the conception *triangle*.

Conceptualism. In the scholastic philosophy of the middle ages, the system which allowed the real existence of universals, but only as ideas conceived by the mind. This was the system of Abelard, as distinguished from the nominalism of Roscelin (who denied the existence of any universals except as words or propositions) and the realism of the Greek philosophers. (Hallam's *Literary History*, part i. ch. iii.; Milman's *Latin Christianity*, book viii. ch. v.)

Concertante (Ital.). In Music, a term expressive of those parts of a musical composition that are especially prominent throughout the piece, as distinguished from those that play only in accompaniment or subordinate parts.

Concerted Piece. In Music. A piece wherein several solo voices or instruments take prominent parts.

Concertina. In Music, a modern instrument, of the free-reed species, invented by Professor Wheatstone. It has several octaves in compass, with a perfect scale, but is very portable, being carried in the hands, which work the bellows, while at the same time the fingers act upon small keys, to admit the wind to the several reeds. It is capable of considerable expression, and has become very popular.

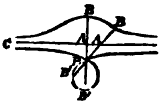
Concerto (Ital.). In Music, a piece composed for a particular instrument, such as the pianoforte, violin, clarinet, &c., which bears the chief part in it, and is usually accompanied by the full band.

Concetti (Ital.; rendered by English writers on rhetoric *conceits*). Ingenious thoughts or turns of expression, points, jeux d'esprit, &c. in serious composition. In the sixteenth century, the taste for this species of brilliancy, often false and always dangerous, spread rapidly in the poetical composition of European nations, especially in Spain and Italy; where the name of *concetti* was applied rather in a good than a bad sense, the critical taste being much perverted. Tasso is not free from *concetti*. After his time they became offensively prominent in Italian poetry for a century afterwards: Marino and Filicaia offer strong examples. In France, the mode of concetti was equally prevalent in the seventeenth century, and was peculiarly in vogue with the fair critics of the Hôtel Rambouillet, so well known by Molière's *Précieuses Ridicules*. In England, Donne and Cowley are instances of a style full of *concetti*.

Conchifera (Lat. concha, *a shell*, and fero, *I carry*). A name applied by Lamarck, Schweigger, and Latreille to all molluscs which are protected by a bivalve shell. [Lamellibranchiates and Brachiopoda.]

Conchoid (Gr. κογχοειδής). The name given to a curve invented by Nicomedes for the solution of the two famous geometrical problems of antiquity—the *duplication of the cube* and the *trisection of an angle*. It is constructed as follows:—

Let P be a given point through which any straight line is drawn to cut or meet another straight line CD given in position; if segments AB, AB′ of a given length h be taken on each side of CD, the points B, B′ will trace the conchoid.



Taking P as pole and the perpendicular ($=a$) on CD as axis, the polar equation of the *conchoid* is clearly

$$(r \pm h) \cos \theta = a;$$

in rectangular coordinates, the equation therefore is

$$h^2x^2 = (a-x)^2 (x^2 + y^2).$$

The curve, consequently, is of the fourth order and sixth class, having a double point at the origin. [Conjugate Point.] The line CD is an asymptote; meeting the curve in four consecutive points at infinity.

Conchoidal. A term used in Mineralogy to denote that the fractured surface of a mineral exhibits curved concavities, more or less deep, and bearing a resemblance to the valve of a shell. Many of the brittle minerals, as Flint, Rock Crystal, Sulphur, Anthracite, &c., exhibit this appearance in a very perfect manner.

Conchology (Gr. κόγχη, *a shell*, and λόγος). The science of shells: that department of Malacology which treats of the nature, formation, physiological relations, and classification of the hard parts or skeletons of the molluscous animals.

As Osteology, inasmuch as it relates to the nature, developement, and physiological subserviences of the skeletons of the vertebrate animals, is a science in the strict acceptation of the term, so also is Conchology under the like applications; but as no naturalist has yet conceived a classification of vertebrate skeletons independently of the softer organs of the body which they support and protect, and as, notwithstanding that the complex internal skeletons of the Vertebrates are closely related to their general structure and habits, the classification of these parts would not in all cases tally with the natural arrangement of the animals to which they belonged, a classification of shells merely, apart from a consideration of the molluscous animals by which they are secreted, must be still less scientific. For shells, instead of consisting, like bones, of living organised substance permeated by blood-vessels, absorbents, and nerves, are mere inorganic laminated, concretionary, or crystalline deposits of calcareous earth, more or less combined with albuminous matter: they are also formed in the skin, and are appendages to the dermal system, which in all classes of animals is the principal seat of variety. In many cases, therefore, there exists very little correspondence between the structure or even the presence of a shell and the general character of the organisation of a mollusc; and the absence of uniformity between the condition of the shell in closely allied species is exemplified in the

highest as well as the lowest classes of the molluscous sub-kingdom. The argonaut, the poulp (*Octopus*), the calamary, the cuttle-fish, and the spirula, all possess the same peculiar and highly developed organisation; and in a classification founded on general structure, and expressive of the true affinities of its objects, they must rank in the same order of their class. But the shells of these molluscs present respectively the following conditions: the first, a simple external, light, elastic, subtransparent, but calcareous discoidal univalve; the second, two internal, friable, subtransparent styles, composed of hardened albumen; the third, an elongated, feather-shaped, horny plate; the fourth, an internal, compressed, oval, laminated, friable, calcareous mass; the fifth, an elongated, cylindrical, conical shell, twisted spirally in the same plane, divided into chambers by calcareous partitions, perforated by a siphon, and partly internal, partly external, in its situation. Now, in a system of Conchology, understood as the classification of shells in the abstract, these productions would necessarily be dispersed into five widely different groups; and in like manner, the small, thin, and flat plate, which is buried in the substance of the mantle of the slug, would be far removed from the large external spiral shell of the snail.

But no conchologist groups together his shells strictly and exclusively according to their resemblances. All the testaceous productions of the Cephalopods, now that the real affinities of these molluscs are known, are arranged in the same group, notwithstanding their striking discrepancies of texture and form and of relative size and position as related to the bodies of their fabricators: so likewise with the shells or their rudiments of the air-breathing Gastropods, or of the Pteropodous Mollusca. In short, every purely conchological system must undergo modifications corresponding with the progress which is made in the knowledge of the true natural affinities of the molluscous animals; and the progress of Conchology is therefore essentially connected with that of MALACOLOGY, under which term an outline of the most approved classification of the Mollusca and their shells will be found.

Under the present head will be briefly treated those points which relate to Conchology as a science; viz. the developement, structure, configuration, and physiological subserviences of shells.

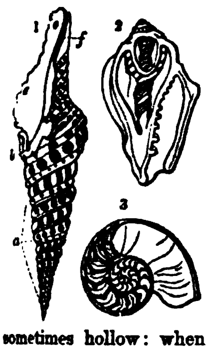
The formation of a shell commences with the exudation of layers of albumen from the outer surface of the mantle or skin of the embryo mollusc, which is generally followed by the admixture of rhombic or prismatic crystalline particles of the carbonate of lime; and this first-formed shell of the embryo constitutes the nucleus of the shell of the mature mollusc. The nucleus is developed in most cases before the embryo quits the egg-coverings, but it is never 'coeval with the first formation of the animal;' it is preceded by several distinct stages in the developement of the embryo. The subsequent growth of the shell depends upon the deposition of fresh layers to the inner surface of the circumference of those previously formed; beyond which the new-formed layers extend in proportions which determine the figure of the future shell.

Sometimes the calcifying margin of the mantle extends outwards at an obtuse or right angle to the last-formed margin of the shell; and after having deposited a calcareous plate in this position, is retracted and absorbed, to be again similarly produced and extended after ordinary growth has proceeded to a certain extent. It is to this periodical growth of the mantle and the plethoric condition of the calcifying vessels that the ridges on the exterior of the shell in the *Venus plicata* among Bivalves, and in the *Scalaria pretiosa* among Univalves, are due. Should the mantle, instead of being uniformly extended, send outwards a number of detached tentaculiform calcifying processes, these will form a row of spines corresponding in length and thickness to the soft parts on which they are moulded: and as the calcifying processes continue to deposit shelly material during the progress of their absorption, the spines, which were at first hollow, thus become solidified, and are soldered to the margin of the shell. This developement of calcifying processes or filaments of the mantle and spines may likewise alternate with periods of the ordinary formation of the shell; and thus the exterior of the shell may become bristled with rows of spines, as in some species of *Spondylus*, and in the *Murex crassispina*.

The most simple form of shell is the cone, which may be much depressed, as in the genus *Umbrella*; or extremely elevated and contracted, as in the *Dentalium*; or of more ordinary proportions, as in the limpets (*Patellæ*). The apex of the cone is oblique and excentric; directed towards the head in the limpets, the argonaut, and the nautilus, but in most other molluscs towards the opposite extremity of the body. A shell may consist of one piece, as in the Inopercular Univalves; or of two pieces, as in the Opercular Univalves and most Bivalves; or of three pieces, as in *Terebratula*; or of four or more pieces, as in some of the *Pholades* and the Multivalves proper, or Chitons. With respect to the operculum, this part is sometimes calcareous, but it consists frequently of albuminous membrane only, or is *horny*; thus presenting the condition which the univalve shell itself presents in certain genera, as *Aplysia*, *Loligo*, &c.

The conical univalve shell is generally spirally convoluted; sometimes, as in the *Nautilus* (fig. 3), in the same plane, more usually in an oblique direction, as in figs. 1 and 2. As a general rule, the spiral univalve, if viewed in the position in which its inhabitant would carry it if it were moving forwards from the observer, is twisted from the apex downwards, from left to right, the spire being directed obliquely towards the right (*a*, fig. 1, indicates the spiral turns of *Pleurotoma*). In certain genera, as *Clausilia*, *Physa*, the shell is twisted

in the opposite direction; such shells are called *perverse* or *sinistral*. Some species of *Bulimus*, *Partula*, and *Pupa* are sinistral; and a few marine shells, as *Fusus reversus*, also exhibit the reverse of the ordinary disposition of the spire. The part around which the spiral cone is wound is termed the *columella*. This is sometimes simple, sometimes plicated, as in the *Voluta musica* (fig. 2); it is also sometimes solid, sometimes hollow: when the latter, its aperture is termed the *umbilicus* (*f*, fig. 1). The opening forming the base of the spiral univalve is bounded by an inner lip *d*, and an outer lip *e*; the inner lip offers a smooth convex surface, over which the foot or locomotive disc of the mollusc glides to reach the ground.



In many Univalves, the aperture of the shell is entire; in others it is broken by a notch, or perforated by one or more holes; or a portion of it is produced into a canal or siphon (*c*, fig. 1); or it may present a pallial notch (*b*, fig. 1) opposite to the siphon. These modifications are important, on account of the constancy of their relation to certain conditions of the respiratory organs: thus the conchologist, in grouping together all the spiral univalve shells of which a part of the margin was either notched or produced into a grooved siphon, would really indicate a very natural tribe of Mollusca, every species of which he might be assured was aquatic and marine, and breathed by means of two gills having a pectinated structure, to which the water is conducted by a fleshy tube. Were a like correlation between the shell and its inhabitant to hold good in other families of Mollusca, the classification of shells would then be a subject of much importance, and worthy the attention of the scientific naturalist: unfortunately, the reverse of this is frequently the case.

The part called the *operculum*, which is present in certain univalve molluscs, is a plate consisting of layers of sometimes calcified, sometimes uncalcified, albumen, attached to a disc at the back part of the foot, and forming, when this is retracted, a more or less perfect defence to the outlet of the shell.

Some opercula increase by the addition of matter to their entire circumference; and these are either concentric, as in *Bithynia* and *Paludina*, or excentric, as in *Ampullaria* and most of the Pectinibranchiate molluscs: other opercula grow by the addition of matter to part of their circumference; and these are either spiral or imbricated: in the latter, the layers of growth succeed each other in a linear series. No operculum presents an annular form. As the operculum sometimes varies in structure in species of the same genus, as, e.g., of *Vermetus*; as, moreover, this part is inconstant even as to its presence in species of the same genus, as in the Volutes, Cones, Mitres, and Olives; and as some genera in a natural family, as *Harpa* and *Dolium*, among the Buccinoids, are without an operculum, while the other genera of the same family possess that appendage, it obviously affords characters of very secondary importance in a scientific classification of the Univalve Mollusca. Much confusion indeed might have been introduced into the science of Malacology, if the opinions of those conchologists who have proposed to classify shells from the modifications of the operculum had been much respected by naturalists.

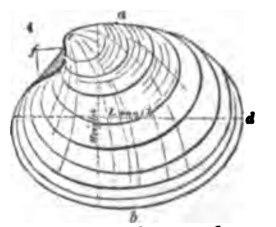
True bivalve shells are peculiar to the Acephalous Mollusca; and their presence is constant, although they are in a few instances too small to cover the whole of the body, and in the ship-borers (*Teredo*) exist only as small instruments, limited to the function of excavating the burrows inhabited by these molluscs. But all the species in which the bivalve shell is inadequate to the protection of the whole of the body derive extrinsic defence by burrowing in sand, or stone, or wood: and they also commonly line their burrows with a layer of smooth and compact calcareous matter, forming a tube. This calcareous tube, in some cases, is of considerable size and thickness, as in the *Teredo gigantea* or *Septaria* of Lamarck. In the *Clavagella* one valve, and in the *Aspergillum* both valves, are soldered to this tube, which, in the latter, presents a peculiar modification of its exposed extremity, which resembles the end of the spout of a watering-pot. No two shells can present a greater contrast than do those of the *Placuna* and *Aspergillum*; yet the organisation of their respective constructors is essentially the same. In a classification of shells, the calcareous tubes of the *Dentalium*, *Serpula*, *Aspergillum*, *Vermetus*, &c. would be associated in the same general group; but we need only to observe how these products of animals, belonging not only to different classes, but to distinct primary divisions of the animal kingdom, are arranged in the cabinets of collectors, to be convinced that Conchology, as a classificatory science, apart from Malacology, no longer exists.

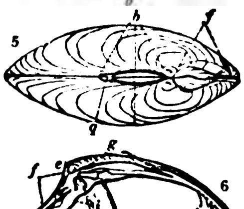
With regard to the structure and physiological relations of bivalve shells, it may be observed, first, that in all Acephalous Mollusca which breathe by distinctly developed lamellated gills (*Lamellibranchiata*), one valve corresponds to the left, the other to the right side of the animal; but in the Brachiopodous Bivalves, one valve is applied to the ventral, and the other to the dorsal aspect of the animal.

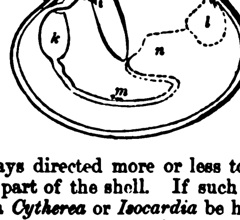
In all the Lamellibranchiate Bivalves which are free, the two valves are symmetrical, and the shell is termed *equivalve*: in all those which adhere by one of their valves to foreign bodies, this valve is deeper and larger than the unattached valve: such shells are termed *inequivalve*. Of those Acephalans which are attached

to foreign bodies by means of a byssus, some, as *Tridacna*, *Saxicava*, and *Bysso-arca*, are equivalve, and both valves are notched, to form the hole for the passage of the byssus; while others, as the *Pectines*, *Aviculæ*, and *Peda*, are inequivalve, the byssus passing through a groove in the right valve.

Linnæus, who first introduced precision into the description of shells, defined several points requisite to be noticed in the outer and inner surface of a bivalve shell; but the epithets, which his comparison of the bivalve selected for illustration induced him to attach to those parts, have been abandoned and changed. If the shell of the common cockle (*Cardium edule*) be examined, each valve will be seen to be produced into a conical prominence, bent towards, and nearly meeting at, that part by which the valves are joined together. These prominences are termed the *umbones*. The apex, or beak of the umbo, corresponds to the apex of the univalve shell, and is the point at which the developement of the bivalve commences. When the apex is directed in the transverse plane of the shell, and so placed that a bisection of the shell in that plane through the apices shall divide the valve into two equal parts, the shell is termed *equilateral*: of this form the common scallop (*Pecten*) is an example. When, upon a similar division, a slight difference is observed in the two valves, the shell is termed *sub-equilateral*; but where the difference is well marked, it is an *inequilateral* bivalve. When the apex is bent, as is commonly the case, out of the transverse plane,







it is always directed more or less towards the anterior part of the shell. If such a Bivalve shell as a *Cytherea* or *Isocardia* be held before the observer, with the umbones directed forwards and the hinge above—in the position, in fact, in which the living animal would place itself if it were creeping forwards from the observer—the right valve will of course correspond with the right hand of the observer, and the left with the left. (Fig. 4 is the left valve of a *Cytherea*; *a* is the upper or dorsal margin, *b* the lower or ventral margin, *c* the anterior, *d* the posterior margin, *e* the apex of the umbo, *f* the lunule.) Now, if a Bivalve in which the apices have a spiral twist, as an *Isocardia* or *Diceras*, be placed in the above position, and compared with the univalve shell of a *Concholepas* or *Purpura*, it will be seen that the left valve corresponds with the ordinary or dextral spiral Univalve, and the right valve to the perverse or sinistral Univalve. Instances, however, have been met with where the characters of the valves of the Bivalve were reversed, like the occasional exceptions in the *perverse* sinistral Univalves before mentioned.

When the circumference or margin of one valve fits exactly at every part to that of its fellow, it is said to be *regular*, or entire; but if it be notched at any part, so as not to come into contact with the corresponding part of the opposite valve, it is *irregular*, or emarginate.

With respect to the outer surface of a Bivalve, the parts called *umbones* and *apices* have already been defined, and the upper or dorsal and anterior margins of the valve determined. If we continue our examination of the exterior surface of the Bivalve, we shall find, in most cases, anterior to the apices, a depression of variable extent and depth. This is the *lunule* (*f*, fig. 5): it may be cordiform, or crescentic, lanceolate, oval, oblong, deep, superficial, &c. Behind the apices is another depression, longer and narrower than the lunule, and which is called the *fissure* (*g*, fig. 5), and its margins *lips*. Behind the fissure there is sometimes a small depression, called the *suture* (*h*, fig. 5). The general more or less convex surface of each valve is called the *venter*, or belly, which terminates in the *limb*, circumference, or margin.

The most important part of the margin is that which is modified to form the joint or hinge upon which the two valves open and shut. This part is called the *cardinal edge*, and generally presents certain prominences and depressions, the projections of one valve interlocking with the depressions of the other. The projections or *teeth*, together with the cavities or *cardinal pits*, are very regular in their formation in each genus and species of Bivalve. What is of more importance is, that every modification in the structure of the hinge is generally found to coincide with some recognisable and more or less important difference in the organisation of the soft parts; so that conchologists have justly attached great value to the characters derivable from the hinge, especially for the purpose of generic distinctions. When the teeth are situate beneath the apex or centre of the hinge, they are called *cardinal*; when they are removed from the centre of the hinge, they are named *lateral teeth* (*i*, fig. 6); when

two only are present, one is called *anterior*, the other *posterior*; when there are three, they are distinguished respectively as the *anterior*, *median*, and *posterior* teeth; but when the hinge is composed of a great number of teeth, it is said to be *serial*, as in *Arca*. The direct medium of union of the two valves is a dense fasciculus of elastic albuminous fibres, generally of a brown colour, called the *ligament* or *elastic ligament*. The fibres of this part are attached by their extremities to the two valves, which, in most cases, present a particular depression for their reception. The ligament is always so long as to prevent the actual closing of the valves, except when its elasticity is overcome by a certain force, as by that of the contraction of the adductor muscle or muscles. Thus the inorganic power of elasticity is made the direct antagonist of a vital and muscular contraction; and as the patent condition of the bivalve shell is that which the exigences of the animal most constantly require, it is assigned to a force which can act without ever causing fatigue, while the occasional or protective action of forcibly closing the valves is due to an action under the immediate control of the will or instinctive sensation. The modifications of the internal surface of a bivalve shell are, perhaps, the most interesting and important; as they relate immediately to the structure of the soft parts, and bespeak the general nature of the organisation of the animal. Hence they afford the characters by which the habits and structure of an extinct genus may be to a great extent determined.

The adductor muscles leave well-marked impressions on the inner surface. If there be but one muscular impression on a valve, then it belongs to a *monomyary* or *unimuscular* Bivalve; and if neither valve of a fossil shell presenting this character has been immediately attached to foreign bodies, then the laws of coexistence warrant the inference that the constructor of such a Bivalve possessed a byssus, and the muscular organ called the *foot*: but that the foot was developed only to the extent adapted to serve as an instrument for moulding the soft fibres, and regulating the attachment of the byssus.

If each valve of a bivalve shell exhibit two muscular impressions, it proves the species to be *dimyary* or *bimuscular* (*k* is the anterior, and *l* the posterior muscular impression in the *Cytherea*, fig. 6); if, moreover, there be a thin small muscular depression beneath the cardinal hinge, we have then an indication that the animal possessed a large foot, organised to serve as a locomotive or burrowing fleshy organ, the retractive muscle of which was inserted in the above depression. The line continued between the impressions of the two adductors indicates, by its depth and breadth, the developement of the muscular margin of the mantle, and is called the *pallial impression* (*m*, fig. 6). If this line be continued uninterruptedly, parallel with the margin of the valve, we may be assured that the animal was either without siphons, or had them of very small size; but if the pallial line be broken by an angular notch (*n*, fig. 6) continued inwards before its junction with the posterior muscular impression, then it may be certainly inferred that the animal had well-developed muscular tubes or siphons for respiration, with all the concomitant powers and habits. Thus the general organisation of the soft and perishable fabricator of a bivalve shell may be as certainly determined by the evidence of its fossilised enduring case, as that of a vertebrate species by the structure of its skeleton. The more immediate affinities of the Bivalve are revealed by the modifications of the hinge.

It sometimes happens, however, that the whole of the internal or nacreous stratum of a fossil bivalve shell is destroyed, especially if it have been embedded in porous chalk; and as the muscular impressions and the articular structure of the hinge are composed exclusively of the inner stratum of the shell, the means of determining the nature and affinities of the animal in that case are lost; and, unless the observer were acquainted with the texture and structure of the bivalve shell, he would run the risk of mistaking the part of a decomposed Bivalve for the whole of some nondescript *Acardian* species, as those Bivalves are termed in which the hinge is naturally wanting.

Each valve of a bivalve shell consists of two strata, distinct in texture and in their organs of formation. The internal stratum is deposited in nearly parallel layers, by the central and posterior parts of the mantle: it forms the smooth iridescent lining of the shell called *mother-of-pearl*. The outer stratum is secreted by the thick glandular margin of the mantle, and consists of conical fibres, resting obliquely by their apices, or narrower ends, upon the nacreous laminæ. The thickness of the two strata of the shell always preserves an inverse ratio, the outer one being thinnest at the *umbo*, and thickest at the margin; the inner one the reverse.

One hundred parts of oyster-shell give—

Carbonate of lime	98·3
Phosphate of lime	1·2
Insoluble animal matter . .	0·5
	100·0

Most univalve shells are composed of three strata, which consist of layers of rhombic or prismatic crystals, differently arranged in the adjoining strata. The chief difference of structure depends on the relative quantity of the animal to the earthy constituents of the shell.

Hunter discovered that the molluscous inhabitants of shells had the power of absorbing a part of the shell previously formed; a fact which has been confirmed by subsequent observers, and which gives rise, in several species, to singular modifications in the form and structure of the shell in the progress of growth. Another change of form is due to the physical decomposition or destruction of a part

of a shell: this occurs to the apex of certain Univalves, after they have been evacuated by their original occupant, in the widening and lengthening of the shell to accommodate it to an increase of bulk. Such shells are said to be *decollated*, as in *Cerithium decollatum*, *Helix decollata*, &c. An analogous partial decomposition always obtains in many *Uniones* and *Anodontæ*, of which the *umbones* are then said to be *decorticated*, the external coloured layer or bark of the shell being worn away. There is no general law or uniformity in the mode in which the inhabitants of either univalve or bivalve shells dispose of that part of their calcareous abode which they evacuate in the progress of their growth. In the decollated shells, the vacated spire is partitioned off by the formation of a thin nacreous plate; and its walls being thin and fragile, it is then broken away, as above described. In *Vermetus gigas*, the vacated portions of the tube are successively partitioned off, and a series of concave plates or septa developed; but the part of the shell thus divided into chambers, or *camerated*, is retained. The *Spondylus varius*, among Bivalves, offers an analogous structure. In the pearly nautilus, the vacated portion of the shell is converted into a series of chambers by the developement of calcareous septa in greater number and regularity than in any Gastropodous Univalves; and the partitions are perforated by a membranous tube or siphon, the deserted chambers being converted, by the superaddition of this part, into a hydraulic machine, perfectly adapted to the habits and exigences of the animal. The like structure, with various modifications, obtains in the extensive, but mostly extinct, race of 'Siphoniferous' Cephalopods. In the Argonaut, the vacated spire of the shell is not partitioned off, but is retained in full communication with the inhabited part, and made subservient to the reproductive economy of the species. In the *Magilus antiquus*, the posterior part of the shell, as it is deserted, is progressively filled up with a dense, solid, subtransparent crystalline deposit of carbonate of lime. A deposit of similar calcareous material, in a less degree, fills up the deserted spire of the shell in some species of *Cassis*, *Mitra*, *Triton*, &c.; and in the long *turreted* shells of the *Terebræ*, *Cerithia* &c. the deposition of this dense material in the vacated apex is the preventative, instead of the cause, of decollation.

Conclave (Lat. con, *together*, and clavis, *a key*). The assembly of cardinals, especially so called when met for the election of a pope. It begins the day following the funeral of the deceased pontiff. The cardinals are locked up in separate apartments, and meet once a day in the chapel of the Vatican (or other pontifical palace), where their votes, given on a slip of paper, are examined. This continues until two-thirds of the votes are found to be in favour of a particular candidate. The ambassadors of France, Austria, and Spain have each the right to put in a veto against the election of one cardinal, who may be unacceptable to their respective courts.

Conclusion (Lat. conclusio). In Logic, that proposition which is inferred from certain former propositions, termed the *premisses* of the argument.

Concomitance (Lat. con, and comitor, *I accompany*). The relation which exists between two sets of variables, such that when those of the one set are replaced by certain functions of themselves, those of the other set become likewise replaced by definite functions of themselves. The most important kinds of concomitance are cogrediency and contragrediency. [COGREDIENT and CONTRAGREDIENT.]

Concomitant. A term of modern Algebra, applied to a quantic which is related to a given system of quantics in the following manner: Let u_1, u_2, &c. be a given system of quantics, which by linear transformation of their variables become converted into u_1', u_2', u_3', &c., and let u and u' be quantics respectively derived from these two systems according to the same definite rule; then if u is converted into $m\,u'$, where m denotes some power of the modulus of transformation, by the *same* or by *reciprocal* systems of linear transformations of its variables or facients u is said to be a *concomitant* of the given system u_1, u_2, &c. If u should contain no variables, and be therefore identically equal to $m\,u'$, it is called an *invariant* of the given system of quantics; if, containing variables, it should be converted into $m\,u'$, by the *same* linear transformations it is called a *covariant*; but if its conversion into $m\,u'$ should require linear transformations *reciprocal* to those first employed, it is called a *contravariant*. Lastly, if u should contain two sets of variables and still become converted into $m\,u'$ by transforming one set by the original and the other by the reciprocal substitutions, it is called a *mixed concomitant* of the given system of quantics. Concomitants, therefore, embrace covariants and contravariants; in describing the latter terms, further details and illustrations will be given. It is scarcely necessary to add that the given system of quantics may consist of a single individual.

Concord (Lat. concordia). In Music, a combination of two or more sounds, forming harmony agreeable to the ear.

Concordance. A Biblical index, in which all the leading words used in Scripture are arranged alphabetically, and a reference made to the various places in which they occur. The importance of this class of works was early appreciated, and a vast deal of labour has been expended in compiling them. Concordances have been made of the Greek Septuagint, the Greek Testament, the Latin Vulgate, and the English Old and New Testaments; a full list of which will be found in Watt's *Bibliotheca Britannica*, and in Orme's *Biblio. Biblica*. The first Concordance was compiled by Cardinal Hugues de St. Cher, who died in 1262. The best English Concordance is that of Cruder

which appeared in 1737, and still maintains its ground as an authority,

Concordat. An agreement or convention upon ecclesiastical matters made between the Pope and some temporal sovereign, as that between Pius VII. and Bonaparte in 1802, by which the Roman Catholic religion was re-established in France; on which occasion the Pope recognised the new division of France into sixty sees, instead of the much greater number which had existed before the Revolution, the payment of the clergy from the national revenues, and the appointment of the bishops by the civil authority. Originally the term was applied to agreements regulating mutual rights between bishops, abbots, priors, &c. Many of the German powers possess concordats with the see of Rome; but the most celebrated is that of August 18, 1855, between Austria and the Pope, whereby the former surrendered more than all the ground which had been won from the latter by Joseph and Leopold; it appears, however, to be yet (1865) unsettled how far this concordat has become part of the law of the land.

Concrete. [Béton; Cement.]

Concrete Term. In Logic, is so called when the notion of an attribute is regarded in conjunction with the object that furnished the notion; as *foolish* or *fool*. When the attribute is regarded in itself, it is called an *abstract term*; as *folly*.

Concussion (Lat. concussio, from concutio, *I shake*). A term generally applied to injuries sustained by the brain, independent of fracture of the skull, as from blows and falls. More or less insensibility, sickness, impeded respiration, and irregular pulse are the first symptoms; but these subside, and the sufferer often becomes more easy and collected; yet, although the symptoms apparently abate, dangerous inflammation may be going on, and a fatal termination ensue. In all accidents of this kind, where, as is commonly said, persons are *stunned*, the most cautious treatment should be adopted, and no time lost in obtaining skilful professional aid.

Concussion. In Law, the unlawful forcing of another by threats, or by the abuse of office or rank, to yield up something of value. The term is now unknown to English, though common in foreign jurisprudence.

Concyclic Quadrics. Surfaces of the second order, which give circular sections when cut by the same two systems of parallel planes. Thus,

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} + \lambda(x^2 + y^2 + z^2) = 1,$$

for any values of λ represents a quadric surface concyclic and concentric with the ellipsoid (a, b, c). A system of concentric and concyclic quadrics may be regarded as a particular case of a system of quadrics having a common curve of intersection, and the reciprocal of such a system will be a system of confocal quadrics. The properties of one system, therefore, may be at once deduced from those of the other. [Confocal Quadrics.]

Condensation (Lat. condensatio). The rendering a body more dense, compact, or of greater specific gravity, by bringing its particles into closer proximity. The term is commonly applied to the conversion of a vapour or gas into a liquid or solid either by the application of cold or pressure.

Condenser. The common name of various modifications of apparatus used in cooling heated vapours down to the temperature at which they become liquid. The *worm-tub* form is that most frequently employed in distillations. It is simply a long metal pipe coiled round the inside of a tub, one end being attached to the still, the other passing out near the bottom of the tub; cold water placed in the tub cools, and causes to condense, any vapour that may be passing through the worm. When in use the water in the tub is constantly renewed by pouring fresh quantities through a long funnel reaching to the bottom, the heated water being allowed to flow off by a spout near the top. *Liebig's condenser* consists of a glass tube passing through a wider and shorter metal tube, the two being fixed together at each end of the metal tube by a perforated cork. An entrance pipe and exit pipe are placed at opposite extremities of the metal tube, so that a current of cold water can be made to circulate in the space between it and the glass tube.

Condition (Lat. conditio). In Law, has been defined in the most general sense, 'A restraint annexed to a thing, so that by the non-performance the party shall receive loss, and by the performance advantage.' It is most commonly used to signify a term whereon a grant is made: e.g. grant of an estate to A, on condition that the grantee shall pay such a sum on such a day, or else his estate shall cease. Conditions of this description may be implied by law: as, where tenant for life enfeoffs a stranger in fee simple, he forfeits his estate for the breach, as it is said, of the implied condition not to grant a greater estate than his own. Conditions are *precedent*, when an estate is gained on the performance of them; *subsequent*, when the condition is to be performed after the acquisition of the estate which is lost by its non-performance. But the distinctions between these two classes are numerous and minute. In general, where a condition is of such a nature that compensation can be made for its non-performance, equity will relieve the party breaking it from the consequences of the breach on making such compensation.

Conditional Proposition. In Logic, is one which asserts the dependence of one categorical proposition on another: e.g. 'If the wind changes, it will rain.' The proposition from which the other results is termed the *antecedent*; the resulting proposition the *consequent*. A conditional syllogism is one in which the reasoning depends on a conditional proposition. It is of two sorts, *constructive*

and *destructive*; as, 1. If A = B, then C = D; but A = B, therefore C = D. 2. If A = B, then C = D; but C is not equal to D, therefore A is not equal to B. The connection between the antecedent and consequent of a conditional proposition is termed the *consequence*.

Condottieri (Ital. *leaders*). In Italian History, a class of mercenary adventurers in the fourteenth and fifteenth centuries, who commanded military bands, amounting to armies, on their own account, and sold their services for temporary engagements to sovereign princes and states. One of the earliest and most famous among those leaders was the Englishman Sir John Hawkwood, who commanded in various Italian wars about the time of our Edward III. The bands under command of the Condottieri were well armed and equipped. Their leaders had in many instances considerable military skill; but, as they took no interest in national contests, except to receive pecuniary advantages, the wars between them became a sort of bloodless contests, in which the only object of each party was to take as many prisoners as possible for the sake of the ransom. This singular system of warfare was only put an end to by the more serious military operations of the French, who invaded Italy under Charles VIII. Although many Condottieri acquired much honour as well as emolument, one only attained to high rank and independent power; this was Francesco Sforza, originally a peasant, who in 1451 made himself duke of Milan, and transmitted that sovereignty to his descendants.

Conduction of Impressions. In Physiology, is the propagation of that state or action of a nerve-fibre, which is produced by the application of a stimulus, through the whole length of the fibre; it takes place with immeasurable rapidity, in the same way as electricity is said to be conducted along a wire.

Conductor. In Electricity. [ELECTRICITY.]

Conduit (Fr. from Lat. conductus, part. of conduco, *I lead*). In Architecture, a passage of very narrow dimensions, usually subterranean, for the purpose of secret communication between apartments. The name is also applied to pipes or passages for the distribution of water.

Condurrite. An arsenite of copper, named after the Condurrow Mine near Helstone in Cornwall, where it was originally discovered.

Condyle (Gr. κόνδυλος, *a knuckle*). The rounded head of a bone.

Condylopods, Condylopoda (Gr. κόνδυλος, and πούς, *a foot*). A name applied by Latreille to that subdivision of Encephalous articulate animals which have jointed feet. The Acephalous Cirripeds are excluded from this group, which consequently includes the Myriapods, Insects, Arachnidans, and Crustaceans.

Cone or **Conical Surface.** In Geometry, the surface generated by a right line of unlimited length which moves in any manner so as always to pass through a fixed point. The right line is termed the *generator*, *side* or *edge* of the cone, and the fixed point its *vertex*.

The cone is said to be of the n^{th} order if any arbitrary right line cuts it in n, real or imaginary, points; in other words, if n of its generators lie in any plane through its vertex. It is further said to be of the m^{th} class if through any point (or line through its vertex) m tangent planes can be drawn. The order and class of the cone, therefore, coincide respectively with the *order* and *class* of any plane or twisted curve (*directrix*) upon which the generator may be supposed to rest during its motion. The properties of a cone are best studied by considering any one of its plane sections, for the singularities of both will obviously correspond. Thus to every double or stationary point on the section will correspond a *double* or *stationary edge* of the cone; to every double or stationary tangent a *double* or *stationary tangent plane*, and so on. Plücker's equations connecting the singularities of curves, therefore, are at once applicable to cones. The determination of a cone of given order or class, whose vertex is known, by means of points or planes is also obviously similar to that of a curve of the same order or class by means of points or tangents. [CURVE.]

The term *cone* is sometimes employed in a limited sense to indicate the *solid* enclosed by one sheet of a conical surface of the second order, and the plane of one of its circular sections, the latter being then termed the *base* of the cone. Such a cone is further distinguished as *right* or *oblique*, as the line joining its vertex to the centre of the circle is perpendicular or not to the plane of the base. A right cone is obviously a *cone of revolution*.

CONE (Gr. κῶνος). In Botany, a term denoting that form of inflorescence called a *strobilus*, which is a spike, the carpels of which are scale-like, spread open, and bear naked seeds. Sometimes the scales are thin, with little cohesion; but they often are woody, and cohere into a single tuberculated mass.

Cone of Rays. In Optics, includes all the rays which fall from a near luminous point, or from a single point of a near luminous object, upon a given surface; for example, the object-glass of a telescope: also the rays thrown by the object-glass to its focus.

Confederacy (Lat. confœderatio, from con, *together*, and fœdus, *a league*). In Politics, an alliance of independent states for a common object.

Confederation, the Germanic (by the Germans termed the *Bund*). Was formed at the congress of Vienna: the instrument by which it is constituted bears date June 8, 1815. This union was framed to supply the want of the ancient imperial government, dissolved in 1806. The constituent members are thirty-four monarchical states and four free cities, which enter the confederation as equal and independent. The diet of plenipotentiaries, which forms the representative body of the league, is permanent, and sits at Frankfort-on-the-Maine. When this diet meets as a *general* assembly (plenum), six states, viz. Austria,

Prussia, **Bavaria, Saxony,** Hanover, Wurtemberg, have four votes each; five other states, three each; four, two; the rest, one; making seventy in all. But in the making of fundamental laws, admission of new members into the confederacy, and on religious questions, unanimity is required. In the *ordinary* assembly of the diet, the votes are so apportioned as to make only seventeen in all: this is the assembly in which propositions are discussed, which are decided without discussion in the plenum. This ordinary diet manages the general affairs of the confederation. Austria presides in both diets. The principal objects of the confederation are: the examination of disputes between its members; mutual protection; reciprocal assistance towards securing internal tranquillity; the establishment of constitutions of estates in all the states; the establishment of certain central courts of appeal; legal equality of Christian sects; an international community of civil rights in some points; and finally, the regulation of the condition of mediatised princes and states. [MEDIATISATION.]

Conference. In English Parliamentary usage, a meeting of certain delegated members of the two houses to discuss the provisions of a bill respecting which there is a disagreement between them; usually on the subject of amendments introduced by one and rejected by the other. The principal rules relating to conferences are: 1. That a conference must be demanded by that house which is in possession of the bill. 2. It is the privilege of the House of Lords to name the time and place at which the conference shall be holden. 3. The house which asks the conference must in its message clearly express the subject-matter respecting which it is to be holden. 4. It is usual for the house desiring the conference to appoint a committee to draw up reasons to be offered in support of the measure which the house has adopted. These reasons are communicated by its managers (i. e. delegates) to those of the other house; and it is irregular for any member to go beyond these reasons, or to speak anything except by way of introduction to their delivery. 5. If the reasons alleged on both sides fail in producing agreement between the houses, what is termed a *free conference* is demanded; usually after two conferences have been holden without effect. In a free conference the managers are not tied down to follow a particular line of instructions (although they may have received such instructions from their house), but may discuss the provisions of the measure in a more liberal manner.

CONFERENCE has also been the frequent denomination of meetings of divines for ecclesiastical purposes. The conferences of Hampton Court (1604) and the Savoy (1660), between clergy of the church of England and Puritans and Presbyterians, are well known in English history. The annual meetings of Wesleyan preachers are styled *conferences.*

Confession, Auricular (Lat. auricula, dim. of auris, *an ear*). Is accounted by the church of Rome part of the sacrament of penance. It must be made to a priest, who is under solemn obligation not to reveal it; and must include every mortal sin. As an authorised practice of the church, this usage does not appear to be older than about A.D. 1215. Confession is also prescribed by the Greek church. Among Protestants, the Lutherans have retained it in a modified form; but confession to God is alone required in our church as preparatory to absolution.

Confession of Faith. A formulary setting forth the opinions held by a religious community. The most important documents of this nature published prior to the Reformation are the APOSTLES', the NICENE and the ATHANASIAN CREEDS. [See these arts.] Since that period the Romanists refer, 1. To the decrees and catechism of the council of Trent, as containing a complete exposition, accompanied by an elaborate defence, of their opinions; 2. To the Creed of Pius IV., published in 1564, which begins with a statement of the Nicene creed, and proceeds to declare briefly and explicitly the additional tenets of the Romish church; 3. The exposition of the Catholic faith by Bossuet, as having been sanctioned by the Pope, is considered of secondary authority.

The most authentic symbol of the Greek church is that which was drawn up in 1642 by Mogila, the metropolitan of Kiow. It was approved with great solemnity by the patriarchs and principal clergy of that communion.

The reformed churches have in almost all cases drawn up summaries of their peculiar tenets, and require their ministers to express their assent to them. The church of England requires subscription upon ordination to the Thirty-nine Articles, and the three articles of the 36th Canon which relate to the supremacy of the king, &c. The Book of Common Prayer and the Homilies are also authorised statements of the doctrine of this community.

The symbolic books of the Lutheran church are numerous; the principal are the Confession of Augsburg, drawn up by Melanchthon in 1530: the articles of Smalcald by Luther, (1538); the Great and Little Catechisms of Luther (1529); and the Form of Concord (1579). The original symbol of the Scotch church is called the General Confession of the true Christian Faith, which was adopted by the king and nation, together with the Solemn League and Covenant, in 1581. A second was drawn up in 1660 by some of the principal ministers, in consequence of an order in parliament for that purpose. The Confession of the Westminster Assembly (in 1643) was declared in 1690 by an Act of the Scots Parliament to be the national standard of faith in Scotland.

Confessor (Lat.; Gr. ὁμολογητής). In Ecclesiastical History, the title given to those who have undergone persecution for Christianity short of death. They were peculiarly honoured in the primitive church, together with the

memory of those who had actually suffered (martyrs). In the Romish church, the term is applied to priests authorised to hear confessions.

Configuration. In Astronomy, denotes the position which the planets occupy relatively to each other.

Confirmation (Lat. confirmatio). The laying on of hands by the bishop, for the conferring of the grace of the Holy Spirit; a rite by which a person arrived at years of discretion takes upon himself the performance of the baptismal vow made for him by his sponsors. In the early ages this ceremony seems to have been accompanied very generally with the unction of the forehead. It is retained in the Christian church generally, and is regarded as a sacrament by the church of Rome.

Confiscation (Lat. confiscatio, from fiscus, *a treasury*). In the Civil Law, the punishment of forfeiture of goods or land to the public purse.

Conflict of Laws. The opposition between the municipal laws of different countries, in the case of an individual who may have acquired rights or become subject to duties within the limits of more than one state. In the language of Mr. Burge (*Colonial and Foreign Law*, 1. 5.), 'the right or claim which is in contestation before a judicial tribunal may present a conflict between the laws of the country in which he was born, or had a domicile, or had taken up a temporary residence, or in which his property, the subject of the claim, was situated, or in which the act, instrument, or testament on which the claim is founded was executed, or in which the contestation takes place. In this conflict of laws it becomes an important branch of jurisprudence to ascertain which should be selected, and the principles on which the selection is to be made.' The following are among the principal works on this subject: Rodenburg *On the Conflict of Statutes*, an Essay appended to his treatise *De Jure Conjugum*; Hortius, *De Collisione Legum*; Boullenois, *De la Personnalité et de la Réalité des Lois*; the American judge Story's treatise on the *Conflict of Laws*; and the above-cited work of Mr. Burge, *Commentaries on Colonial and Foreign Laws generally, in their Conflict with each other and with the Law of England*, 4 vols. 8vo. London 1837.

Confluent (Lat. confluens, *running together*). The cohesion or blending together of two bones which were originally separate. The occipital bone of man, ossified from four distinct centres, is an example.

Confluent. In Medicine, this term is applied to eruptive diseases in which the pimples or pustules are not detached, but are so numerous as to form confluent patches, or even to cover the whole surface of the body: hence the term *confluent small-pox*.

Confocal Quadrics. In treatises on Plane Curves, conics which have the same foci are often termed *confocal quadrics*. Such quadrics when they intersect always do so at right angles, and the two tangents from any point to a conic are equally inclined to the tangent, at that point, to the confocal conic which passes through it. The properties of a system of confocal conics, which are very numerous, are given in most text-books, and are deducible from those of conics inscribed in the same quadrilateral, since the lines joining the common foci and the circular points at infinity are common tangents to all the conics of the system. [Focus.] Confocal quadric surfaces are surfaces of the second order, whose principal sections are confocal quadric curves, and a system of such confocal quadrics may be regarded as a system of quadric surfaces inscribed in the same developable, upon which the imaginary circle at infinity and the three focal conics in the principal diametral planes are double lines; the portions of these planes, therefore, which are bounded by the focal conics, must be regarded as special individuals of the system of confocal quadric surfaces. Through any point in space three quadrics can in general be drawn so as to be confocal with a given one, and these three always cut one another in their lines of curvature, since they are mutually at right angles to each other. [Lines of Curvature.] The normals to these three confocals at their point of intersection are the common axes of the several tangent-cones to the confocal quadrics. These tangent-cones are themselves confocal, i. e. have the same focal lines [Focal Lines], and those which intersect do so at right angles, so that any two confocal quadrics which cut one another appear to do so orthogonally from whatever point of view they may be regarded. The quadrics confocal to a given ellipsoid, for example, consist of ellipsoids, of hyperboloids of one and hyperboloids of two sheets. Of these surfaces those of the same species do not intersect one another, but each surface is cut perpendicularly by every confocal of the system which is of a different species. We may add that the reciprocal of a system of confocal quadrics is a system of concyclic quadrics, whence properties of the one system are easily deducible from those of the other. [Concyclic Quadrics.] The like-directed semi-axes of the three confocals which pass through any point, or suitable functions of the same, are termed the *elliptic coordinates* of that point. [Coordinates.]

The theory of confocal quadrics is of the greatest importance in pure and applied geometry, and on this account is usually treated at considerable length in all good text-books. In the celebrated problem of the attraction of an ellipsoid, for instance, the properties of confocal ellipsoids play an important part. [Attraction, Calculus of.] Ivory, in his treatment of this problem (*Encyclopædia Britannica*, art. 'Attraction') was led to the consideration of what he termed *corresponding points* on two confocal ellipsoids; that is to say, points whose distances from any one of the three principal diametral planes, common to the two quadrics, are proportional to the axes of the quadrics which are perpendicular to the plane in question. He has shown that the distance between two points, one on each of two confocal

ellipsoids, is always equal to the distance between their respective corresponding points; an important property frequently referred to as *Ivory's Theorem.* The plane of the greatest and mean axes $2a$, $2b$ of an ellipsoid may be regarded as the limit of a confocal ellipsoid, whose squared semi-axes have become equal to a^2-c^2, b^2-c^2 and 0; so that to every point (xyz) on the ellipsoid will *correspond* a point (ξ, η) in the plane of a, b, determined by the relations

$$\frac{x^2}{a^2}=\frac{\xi^2}{a^2-c^2},\ \frac{y^2}{b^2}=\frac{\eta^2}{b^2-c^2};$$

whence it can be easily shown that the points (ξ, η) which correspond to the points of a line of curvature on the ellipsoid all lie in a conic whose foci are the points corresponding to the umbilics. As a particular case, it follows that to any three points A, B, C on the elliptic section (a, b) of the ellipsoid will correspond three points A_1, B_1, C_1 on the focal ellipse. With respect to three such pairs of points, Jacobi has shown that the distances of any point (xyz) on the ellipsoid from A_1, B_1 and C_1, are connected by the same relations as those which obtain between the distances from A, B and C of the point (ξ, η) in their plane which corresponds to (xyz). This remarkable theorem, known as Jacobi's, is the analogue of the well-known one in plane conics, in virtue of which the distances of any point of an ellipse from its two foci are related to one another in precisely the same manner as are the distances from the same foci of any point in the line which joins them.

Conformable. In Geology. When after the deposit of mineral matter the mass of deposits has consolidated itself, and assumed the definite features that distinguish it from other rocks, it frequently undergoes a change of position before another deposit is thrown down upon it. If the new deposit is parallel to the old one, it is said to lie *conformably* upon it; if it is not parallel, it is described as *unconformable.* These terms are in common use among geologists in reference to all stratified formations. The same terms are used whether the want of conformability is caused by elevation or by denudation of the lower bed.

Congé (Fr.). In Architecture, the same sort of moulding as the echinus, or the quarter-round: also a term applied sometimes to the cavetto; the former being called a *swelling congé,* the latter a *hollow congé.*

Congé d'Élire (Fr. *leave to choose*). The king's writ or license to the dean and chapter to choose a bishop in the time of vacancy of the see; a mere formal proceeding.

Congeners. Species belonging to the same genus.

Congestion (Lat. congestio, from congero, *I heap together*). When there is an unnatural accumulation of blood in the capillary vessels of any part of the sanguiferous system, the organ in which it takes place, and the functions of which are disturbed, is said to suffer under *congestion*: it induces a morbid condition of the vessels of the part affected, which when once established is difficult of removal. Congestion of the brain, liver, or lungs is a frequent effect of fevers, though generally consequent upon a previous morbid condition of the organs.

Conglomerate (Lat. conglomeratus, part. of conglomero, *I heap together*). In Anatomy, glands which are made up of many small glands, the ducts of which unite into one, as the salivary glands.

CONGLOMERATE. In Geology. A rock made up of rounded fragments of various rocks cemented together and re-formed. Conglomerates are sometimes called PUDDING-STONES [which see]. The cementing medium of a conglomerate may be carbonate of lime, silica, or oxide of iron. Sometimes the cement is strong enough to hold the stones and rocks together so firmly that they break more readily than the cement. Conglomerates are of no special geological age, but are met with in various formations.

Congregation (Lat. congregatio, from con, and grex, *a flock*). At Oxford and Cambridge, the assembly of masters and doctors is so called, in which the ordinary business of giving degrees &c. is transacted.

CONGREGATION. In Ecclesiastical language, properly an assembly of the people for the purpose of divine worship. Companies of religious persons, forming subdivisions of monastic orders, are styled in the church of Rome *congregations.* The name is also applied to the congregations of cardinals, which serve as committees for the transaction of business of the see of Rome.

Congregationalists. A sect of Protestant Dissenters, who arose in this country as early as the reign of Queen Elizabeth, when Robert Brown maintained that every society of Christians meeting in one place for religious worship under its own laws and ministers formed a legitimate and independent congregation. The Congregationalists have been called, from their founder, BROWNISTS, and in later times INDEPENDENTS [which see]. Each congregation appoints its own ministers by vote, and can remove them at pleasure. Their chief tenets are: the doctrines of predestination, total depravity, particular redemption, effectual grace and final perseverance.

Congress (Lat. congressus, from congredior, *I go together*). In Politics, a meeting of the sovereigns of states, or their representatives, for the purpose of arranging international matters. The first general European congress was after the conclusion of the Thirty Years' War in Germany, at Münster and Osnabrück, 1648, which was followed by the peace of Westphalia. Remarkable general congresses have been: 1. Of the Pyrenees, 1659; 2. Of Aix-la-Chapelle, 1668; 3. Nimeguen, 1676; 4. Ryswick, 1697; 5. Utrecht, 1713; 6. Aix-la-Chapelle, 1748; 7. Teschen, 1779; 8. Paris, 1782; 9. Versailles, 1785; 10. the Hague, 1790; 11. Rastadt, 1797; 12. Erfurt, 1808; 13. Vienna, 1814, concluded at Paris, 1815; 14. Aix-la-Chapelle, 1818; 15.

Troppau, 1820; 16 Layback, 1821; 17. Verona, 1822. (Phillimore *On International Law*, ii. 45.)

CONGRESS. The title of the national legislature of the United States of America. It consists of a house of representatives, and of a senate. The former is composed of members chosen every second year. The qualification of electors is the same with that required in their respective states for electors to the lower house in the state legislature. The number of representatives is apportioned according to the population of each state, and is altered every ten years, when the census is taken by authority. In making this estimate, the slave population is reckoned only at three-fifths of its amount. There cannot be more than one representative for 30,000 free persons. The senate is composed of two members from each state: the senators are chosen for six years by the legislature of the state. The house of representatives chooses its own speaker: the vice-president of the United States is, ex officio, president of the senate. Bills for revenue purposes must originate in the house of representatives; but are liable to the proposal of amendments by the senate. The senate has the sole power of trying impeachments; but it can only convict by a majority of two-thirds of the members present, and its sentence extends only to removal from office and incapacitation for holding it. The regular meeting of congress is on the first Monday in December annually. Every bill which passes the two houses is sent to the president for approval or disapproval; in the latter case, he returns it, with his reasons, to the house in which it originated: if, on reconsideration, it is passed again by a majority of two-thirds in each house, it becomes law. The powers of congress are strictly limited, and separated from those of the various state legislatures by the constitution.

Congreve Rocket. [ROCKET.]

Congruence. If the difference between two numbers a and b (positive or negative) be divisible by a third p, called the *modulus*, the first two are said to be *congruous* for that modulus. The symbolical expression of this property, first proposed by Gauss, is $a \equiv b$ (mod. p), and is termed a *congruence*. Thus $7 \equiv 2$ (mod. 5); $12 \equiv -2$ (mod. 7); and $15 \equiv 0$ (mod. 3). The modulus being the same, two congruences may be added, subtracted, multiplied or raised to any power, just like ordinary equations; so that if $a \equiv b$, and $a_1 \equiv b_1$ (mod. p); $a + a_1 \equiv b + b_1$, $aa_1 \equiv bb_1$, $a^m \equiv b^m$, in short $F(a) \equiv F(b)$, if $F(x)$ be the symbol of a rational and integral function with integers for coefficients. Further, one congruence may be divided by another provided the members of the latter are prime to the modulus. Thus since $147 \equiv 12$ and $7 \equiv 2$ for mod. 5, we conclude that $21 \equiv 6$. Either member of a congruence is termed a *residue* of the other for the modulus to which the congruence corresponds. [RESIDUE.] Any number a which substituted for x renders $F(x)$ a multiple of p, is said to be a *root* or *solution* of the congruence $F(x) \equiv 0$ (mod. p). It is evident that any number congruous to a will also be a solution; in speaking of the distinct solutions or roots of such a congruence, however, *incongruous* solutions are to be understood. An identical congruence is one which subsists for *all* values of x; in order that this may be the case, its coefficients must obviously be multiples of the modulus. As in the theory of equations, it can be shown that no congruence, of which the modulus is a prime, can have more roots than it has dimensions. It may have less and even none. By FERMAT'S THEOREM the congruence $x^{p-1} - 1 \equiv 0$ (mod. p) has precisely $p - 1$ roots, and from this fact we can deduce the number of roots of other congruences. The arithmetical theory of residues of powers is identical with that of *binomial congruences* of the form $x^m - 1 \equiv 0$, and is of great importance in the theory of numbers. Serret's *Algèbre Supérieure* and Poinsot's *Reflexions sur la Théorie des Nombres* may be consulted with advantage by the student of this branch of the theory of numbers.

Conic Sections. In Geometry, the sections of an ordinary right (or oblique) cone by a plane, are termed *conic sections* or simply *conics*. According to the position of the plane, these sections have received the special names *ellipse*, *hyperbola*, and *parabola*; in a restricted sense the term *conics* applies to these curves only. The ellipse is obtained when the plane of section cuts only one sheet of the cone, and obviously includes, as particular cases, the *circle* and the *point*. The hyperbola results from the section of the cone by a plane which meets both its sheets, and clearly includes, as a variety, a couple of right lines. The only remaining position is the intermediate one where the plane is parallel to one of the sides of the cone, in which case the section is termed a *parabola*; a variety of the latter is clearly a pair of coincident right lines. From this it appears, conversely, that the centre and plane of projection being properly chosen, any given conic may be projected into another of any required species.

The sections of the cone were first studied by the geometricians of the school of Plato. They admitted, however, only the right cone into their geometry; and they supposed the section to be formed by a plane perpendicular to its side. Consequently the three sections were formed from three different cones, the angles at the vertex being right, acute, or obtuse. The parabola was produced from a right-angled cone, the ellipse from an acute-angled cone, and the hyperbola from an obtuse cone. Apollonius of Perga, according to Eutocius, was the first who showed that the three sections may be obtained from the same cone, whether right or oblique, and whatever the angle of its apex; the species of the curve depending on the different inclinations of the plane of the section to the cone itself. It has, however, been established that Archimedes, who flourished about forty years prior to Apollonius, was acquainted with the fact that

the three sections may be derived from the same cone. Pappus, in his *Mathematical Collections*, ascribes to Apollonius the names by which the three sections are designated: the term *parabola*, however, occurs in the writings of Archimedes.

No part of mathematics has been more thoroughly studied than that which treats of the properties of conics, and no curves play a more important part in geometrical and physical enquiries. The treatises on the subject which have appeared since that of Apollonius, and up to the one recently published by Dr. Salmon, are of course too numerous to mention. The ancient method of defining conics has, in modern times, given place to others which do not transcend the limits of plane geometry. Wallis and De Witt appear to have been the first to adopt this method, which has since become universal. The properties of the curves chosen for the purposes of definition have varied from time to time according as geometrical and algebraical methods became more and more perfected. Boscovich defined a conic as the locus of a point whose distances from a fixed point and a fixed line have a constant ratio. The fixed point and line are, respectively, coincident with a *focus* and its corresponding *directrix*, and the conic is an ellipse, parabola, or hyperbola, according as the constant ratio in question is less than, equal to, or greater than unity. According to still more recent geometrical methods, towards whose developement Steiner and Chasles have contributed so much, a conic is frequently defined as the locus of the intersections of corresponding rays of two homographic pencils, or as the envelope of the lines which join corresponding points of two homographic ranges; whence it follows at once, amongst other properties, that a conic is in general determined by five conditions, such as those of passing through five given points, touching five given lines, &c. An infinite number of conics can be found to satisfy four given conditions; the whole system, however, is characterised by stating how many of the conics which it embraces pass through any assumed point, and how many touch any assumed line. These two *numbers* have been termed by M. Chasles (*Comptes Rendus*, 1864) the *characteristics* of the system, since all properties of the latter may be determined by them. M. Chasles' method of characteristics constitutes one of the most important of modern contributions to geometry.

In algebraic geometry it is shown that every equation of the second degree has a conic for its locus, and conversely that the equation of every conic is of the second order. Conics according to the modern method of classification, therefore, are termed *curves of the second order*. [CURVES.] The equation of a conic, rendered homogeneous, being formed by equating to zero any ternary quadric [QUANTICS], conics are also frequently termed *quadric curves* or simply *quadrics*. The quadric represented, in rectangular Cartesian coordinates, $\frac{x}{z}$, $\frac{y}{z}$, by the equation

$$ax^2+by^2+cz^2+2dyz+2ezx+2fxy=0$$

will be an ellipse, hyperbola or parabola according as f^2-ab is negative, positive or zero; it will be a circle if $f=0$ and $a=b$, and will break up into a pair of right lines when the *discriminant*

$$\begin{vmatrix} a & f & e \\ f & b & d \\ e & d & c \end{vmatrix}$$

vanishes. [DISCRIMINANT.]

Conical Point. A point on a surface, every line through which there meets the surface in two or more coincident points. The number of such coincident intersections determines the *order* of the conical point. Conical points are more frequently called *multiple* points. Thus the origin is a *double* point on the surface represented by the equation

$$u_2+u_3=\&c \;.\;.\; =0,$$

where u_i is a homogeneous function of the i^{th} degree in x, y, z. All the generators of the cone $u_2=0$ meet the surface in *three* coincident points, and of these generators the six which lie in the cubic cone u_3 meet the surface in *four* coincident points. The innumerable tangent planes to the cone u_2 are, in an especial sense, tangent planes to the surface, and the double point is a cusp on the section which each determines. The corresponding singularity on the reciprocal surface is easily ascertained.

Conichalcite. A mineral of a green colour, consisting essentially of arsenate and phosphate of copper, with traces of vanadic acid. It occurs at Hinajosa de Cordova, in Andalusia in Spain.

Conidia (Gr. κόνις, *dust*). A term sometimes used in describing Lichens, to denote the bodies which constitute the powdery matter called *soredia*, lying upon the surface of the thalli. By others they are called the *propagula*. Also the little reproductive cells of certain fungi.

Coniferæ (Lat.). In Botany, a natural order of arborescent or shrubby Gymnosperms, inhabiting most parts of the world, and usually both resinous and evergreen. Their real organisation was, for a long period, but little understood, until Brown discovered that the ovules of the entire order are naked. No other race of plants can be named of more importance to mankind than this—first, for their resinous secretions, as turpentine, pitch, Canada balsam, &c.; and secondly, for their timber, which is used under the names of fir, pine, deal, cedar, sandarach, and many others. All the kinds of fir, cedar, juniper, pine, savin, cypress, and arbor vitæ, are species of genera belonging to this order, which appears from geological evidence to have existed in great abundance among the earliest vegetation that clothed the surface of our planet. Their name marks their habit of producing their fruit in cones.

Conine or **Conia.** An alkaloid existing in hemlock (*Conium maculatum*). It is a colourless volatile oil of powerful odour and acrid taste, obtained by distillation of the plant with alkaline water. It is intensely poisonous.

Conirostres (Lat. conus, *a cone*, and rostrum, *a beak*). A tribe of Insessorial birds or perchers, including those which have a thick robust conical beak, as the crows and finches.

Conistonite. A hydrated oxalate of lime from Coniston in Cumberland.

Conite (Gr. κόνις, *powder*). A magnesian carbonate of lime, found associated with certain zeolites, in the form of a powder, at Down Hill, county Derry; also in Iceland, Hessia, and Saxony.

Conium (Gr. κώνειον, *hemlock*). A genus of Umbelliferæ, containing the well-known poisonous weed called Hemlock. This plant, *C. maculatum*, is known by its mouse-like smell; but the technical distinctions reside in the fruits, which are roundish, with five wavy corky ridges on each half, with no oil-channels (vittæ), and the albumen deeply furrowed on the inner side. It grows in hedges and by roadsides, and has a tall erect branched spotted smooth stem, smooth parsley-like leaves, and compound umbels of fruits. It is used in medicine.

Conjoint Degrees. In Music, a term used of two or more notes which immediately follow each other in the order of the scale.

Conjoint Tetrachords. In Music, two tetrachords or fourths, in which the same note is the highest of one and the lowest of the other.

Conjugal Rights. [MARRIAGE, LAW OF.]

Conjugate (Lat. conjugatus, part. of conjugo, *I yoke together*). An adjective frequently used in pure and applied mathematics, with reference to two quantities, points, lines, axes, curves, &c., which present themselves simultaneously and have reciprocal properties.

Conjugate Constituents of a Matrix or Determinant. Are those which are symmetrically placed with respect to the principal diagonal. [MATRIX.]

Conjugate Diameters. In *quadric* curves two diameters are said to be *conjugate* when each bisects all chords parallel to the other; each is the polar of the infinitely distant point on the other, and consequently parallel to the polar of every point on the latter, and therefore to the tangents at its intersections with the curve.

In *quadric surfaces*, three diameters are said to be conjugate when the plane of any two bisects all chords parallel to the third. Such a plane is always parallel to the polar plane of any point on the third diameter, and, therefore, also to the tangent planes at its extremities. The numerous properties of conjugate diameters are given in every good treatise on pure and algebraical geometry.

Conjugate or Reciprocal Lines. [KINEMATICS and ROTATIONS.]

Conjugate Point. This expression, although an objectionable one, is still in general use, and denotes a double point of a curve at which the two tangents are imaginary. Such a point being altogether isolated from the curve, is sometimes called an *isolated point*, and its existence is only detected by the fact that the number of points in which any line through it meets the curve is two less than the order of the curve would lead us to anticipate. In the *conchoid* of *Nicomedes*, for example, which is a quartic curve having the equation

$$h^2 x^2 = (a-x)^2 (x^2 + y^2),$$

the origin is clearly a double point on the curve; the tangents at which are given by the equation

$$a^2 y^2 + (a^2 - h^2) x^2 = 0.$$

If a were greater than h, therefore, these tangents would be imaginary, and the origin would have no consecutive points on the curve.

Conjugate Points, Lines, and Triangles. Two points are said to be *conjugate* with respect to any conic when the polar of one passes through the other. Similarly two lines are conjugate with respect to the same conic when the pole of either lies in the other. Lastly, two triangles or trilaterals are said to be conjugate when each side of the one is the polar of a vertex of the other. In the last case the angle opposite any side and the pole of the latter are *corresponding vertices* of the conjugate triangles, and similarly any side of one triangle and the polar of the opposite vertex are corresponding sides. The three lines joining the corresponding vertices of conjugate triangles always meet in the same point, and the intersections of the three pairs of corresponding sides always lie in a line. A triangle each of whose vertices is the pole of the opposite side is called a *self-conjugate* triangle. Thus the diagonal points of a complete quadrangle (intersections of pairs of opposite sides) form a self-conjugate triangle with respect to every conic which passes through those points. In the modern treatment of the properties of conic sections, the theory of conjugate points, lines, and triangles is of the first importance.

Conjugate Tangents. Any two tangents at a point of a surface are said to be *conjugate* when each there touches all the curves of contact of circumscribed developables having the other for a generator. They are always parallel to a pair of conjugate diameters of the indicatrix, and form, with the inflexional tangents, a harmonic pencil. From the relations which exist between the radii of curvature of a surface and the semi-diameters of the indicatrix [INDICATRIX], it follows at once that the algebraical sum of the radii of curvature of any two normal sections through a pair of conjugate tangents is constant. The above definition of conjugate tangents is that given by Dupin (*Développements de Géométrie*), who first investigated their properties. A simpler definition would be: Any two tangents at a point on a surface such that the tangent plane at a consecutive point on either contains the other. (Salmon's *Analytical Geometry*.)

Conjugates, Harmonic. [HARMONICAL POINTS.]

Conjugation (Lat. conjugatio). In Grammar, is to verbs what *declension* is to substantives—the sum total of the inflexions which they admit, corresponding to the various circumstances of time or mood under which an action is conceived to take place.

Conjunction. In Astronomy. When Mercury and Venus are in a line between us and the sun, they are said to be in *inferior conjunction.* When any of the planets are so situate beyond the sun, they are said to be in *superior conjunction.* Planetary bodies appearing near each other or a star are also said to be in conjunction.

CONJUNCTION. In Grammar, that part of speech which expresses the relation of propositions or judgments to each other. [GRAMMAR.]

Conjunctive Mood (Lat. modus conjunctivus) That modification of the verb which expresses the dependence of the event intended on certain conditions. [GRAMMAR.]

Conjuring (from the Lat. conjurare, *to conspire*). Under this name are included all performances needing sleight of hand, many of which, as the term implies, need the combined action of two or more persons. The ingenious tricks of conjurors have a practical value; for, though the serious arguments which are to refute the pretensions of mesmerists must be sought elsewhere, the credulity of the uneducated may receive some check when they find that the phenomena exhibited by spirit-rappers and magnetisers can be produced by persons who admit that they employ only ordinary human agencies.

Connaraceæ (Connarus, one of the genera). In Botany, a natural order of shrubby or arborescent Exogens inhabiting the tropics, and only distinguished with certainty from *Leguminosæ* by the radicle being remote from the hilum. They approximate very closely to the Cæsalpineous section of *Leguminosæ*; but their want of stipules and regular flowers will usually be sufficient to distinguish them from the great mass of the Papilionaceous section.

Connate (Lat. connatus, *born together*). The anatomical condition under which the ossification of the common fibrous or cartilaginous bases of two bones proceeds from one point or centre, and so converts such bones into one bone; as e.g. the *radius* and *ulna*, or the *tibia* and *fibula* of the frog. These structures are each to the eye single bones; but the mind, transcending the senses, recognises such single bone as being essentially two. The centrums of the two middle segments of the skull in fishes are connate.

CONNATE. In Botany, a term applied to leaves, when an opposite pair are joined together by the base around the stem, so that the latter appears to grow through them.

Connellite. A rare Cornish mineral, supposed by Connell (after whom it is named) to be a compound of chloride and sulphate of copper, with a little water. It occurs in prisms of a dark blue colour.

Connivent (Lat. conniveo, *I wink*). A term used figuratively by botanists in describing the direction of organs, to denote a gradual inward direction, as in many petals. It is the same as *converging.*

In Anatomy, the term is applied to those valvular folds of the lining membrane of canals which are so disposed as to retard, while at the same time they permit, and, as it were, connive at, the passage of the contents of such canals as the *valvulæ conniventes* in the human intestine.

Connoisseur (Fr. from connaître, *to know*). This term is applied to those who are versed in a knowledge of the Fine Arts. The qualifications of a sound connoisseur are rarely met with, and the majority of those who pretend to judge of art come under the description of a well-known Italian author, of being 'conoscitori senza cognizione.'

Cono-cuneus. A skew surface of the fourth order generated by a line moving on two directors, one of which is rectilinear and perpendicular to all generators, and the other is a circle usually perpendicular to the plane which contains its centre and the other director. The rectilinear director, and the line at infinity perpendicular to the latter, are double lines on the surface. [CONOID.] Its equation is

$$c^2 x^2 = y^2 (a^2 - z^2),$$

where a is the radius of the circular director, and c the distance of its centre, on the axis of y, from the rectilinear director or axis of x. The surface was discovered by Wallis.

Conohelix (Gr. κῶνος, *a cone*, and ἕλιξ, *a spiral*). A genus of shells, intermediate between the *Cones* and *Volutes.*

Conoid (Gr. κωνοειδής). A skew surface generated by the motion of a line which always remains parallel to a plane and has a rectilinear director. When, as is usually the case, the directing plane and line are perpendicular to each other, the latter is a *line of striction* on the surface. This line being taken as axis of z, the equation of the surface may always be reduced to the form $z = f\left(\frac{y}{x}\right)$, whatever may be the nature of its second director. Should the latter be also a right line, not in the same plane with the first director, the conoid will be an equilateral paraboloid. [HYPERBOLIC PARABOLOID.] The *Cono-cuneus* of Wallis, already described, is also a conoid, and another well-known example is the *Skew Helicoid*, the curvilinear director of which is a helix having the rectilinear director for its axis. The under surface of a spiral staircase presents a familiar illustration of this conoid. A conoid may be regarded as having three directors, one curvilinear and two rectilinear, one of the latter being at infinity. If the first of these directors be a curve of the m^{th} order, then the order of the conoidal surface will be $2m$, and each rectilinear director will be a multiple curve on the conoid of the m^{th} order of multiplicity. [RULED SURFACE.]

The directing plane being horizontal, the *lines of level* on the surface will of course be the generators; the *lines of greatest slope*, since they cut the former lines perpendicularly, will obviously be projected into circles on the directing plane.

Formerly it was a custom with English writers to give the name *conoid* to any *solid* generated by the rotation of a conic section around one of its axes. In this acceptation, however, the term is obsolete, and has been replaced by that of a *quadric of revolution*.

Conoidal. Of the shape of a conoid. A term applied to the head of an elongated shot of that form. The service projectiles for cannon and small arms have conoidal heads.

Conops (Gr. *κώνωψ, a gnat*). A Linnæan genus of Dipterous insects, characterised by having an elongated, slender, pointed proboscis. It is at present subdivided into the genera *Bucentes*, *Prosena* and *Stomoxys*, *Myopa*, *Zodion*, and *Conops* proper: the larvæ of the latter subgenus are developed within the abdominal cavity of the humble bees, and other Hymenoptera.

Consanguinity (Lat. consanguinitas). In Law, is the relationship between persons descended from a common ancestor; and is either lineal, between persons of whom one is descended in a direct line from the other (son, father, grandfather, &c.), or collateral, between such as lineally descend from the same ancestor (brothers, cousins, &c.). In lineal consanguinity, the father is related in the first degree to the son, the grandfather in the second, and so forth. In collateral, the computation is by beginning at the common ancestor and reckoning downward to the more remote of the persons compared: thus brothers are kindred in the first degree; uncle and nephew, or first cousins, in the second degree; and so forth.

Conscience, Courts of, and of Requests. Were courts for the recovery of small debts. The jurisdiction of these courts arose out of various statutes, beginning with 1 Jas. I. c. 14, their original appointment having been by order in council under Henry VIII. But these courts have been recently abolished, and have been replaced by the county courts, whose jurisdiction extends to the recovery of debts under 50*l*., and ten of which are situated within and around the metropolis.

Conscript (Lat. *Patres Conscripti*, or *Fathers Conscript*). A title of the Roman senators.

Conscription (Lat. conscriptio, *a written list*). The compulsory enrolment, for military or maritime service, of individuals taken from the population at large. The conscription, in the Roman commonwealth, was made not by lot, but by arbitrary selection by the consuls from among the bulk of the citizens when a levy was required. In France the conscription was established during the Revolution, before which period the armies of that country had been recruited by voluntary enlistment. The word is first used in a law of 1798. According to the law as at present established, all citizens are liable to the conscription at the age of twenty. Each arrondissement has its contingent allotted to it out of the total number required for the service, and this number is filled up by lot from the youths liable to the conscription. There are, however, various claims for exemption recognised by the law. The legal duration of the service is seven years. The governments of the United States and of the Confederate States have been compelled to resort to this system during the present war, in order to obtain soldiers.

Consecration (Lat. consecratio). The act of setting apart a person or thing to the service or worship of God: thus a newly built church is consecrated with certain ceremonies, varying in different communities. The admission of a bishop to his office is called his *consecration*.

Consensual Movements. In Physiology, when one motion gives rise to the production of other motions contrary to or independent of the will, the latter are so called: as, e.g., the contraction of the iris when the eye is voluntarily directed inwards.

Consentes Dii. A term by which the Latins distinguished their twelve chief deities—Juno, Vesta, Minerva, Ceres, Diana, Venus, Mars, Mercury, Jupiter, Neptune, Vulcan, and Apollo. The names of these deities and their attributes are for the most part distinct from those which the Greeks assigned to their gods; but as the literature of Rome took its tone and colour from Greece, so its mythology was mixed up with that of the latter country, those deities whose functions most resembled each other being confounded, till the above names became regarded as nothing more than the Latin appellations of the Greek divinities.

Conservatory (from Lat. conservo, *I preserve*). In Horticulture, a glazed structure in which exotic trees and shrubs are planted out in a bed of soil. It is distinguished from an orangery by its having a glazed roof, whilst that of the latter is opaque; and from a greenhouse by the plants being in the free soil, and thus growing from the floor, whilst in the greenhouse the plants are grown in pots placed on shelves, or on a stage or series of shelves rising one above another. They are exclusively used for the plants which are in a growing state during the winter, and are therefore warmed according to the temperature which such plants may require. One of the largest conservatories in the world is that erected at Chatsworth in Derbyshire, by the late duke of Devonshire, for palms and other tropical plants; it covers more than an acre of ground, and is above sixty feet high.

Consideration (Lat. consideratio). In Law, is the material cause of a contract, without which it is not binding on the party. Consideration is said to be either *expressed* or *implied*. An express consideration is where the motive or inducement of the parties to the contract is distinctly declared by its terms; as where a man bargains to sell his land for 100*l*.

It is implied, where an act is done, or a legal demand forborne, at the request of another, without an express stipulation: in which case, the law presumes an adequate compensation for the act or forbearance to have been the inducement of the one party, and the offer of the other; as where a person comes to an inn and makes use of it, intention to pay for the accommodation is presumed. Consideration is also either *valuable*, that is, for money or an equivalent; or it is *of natural affection*, certain degrees of relationship affording in some cases sufficient consideration for a gift.

Consistory (Lat. consistorium, *a place of assembly*). An assembly of ecclesiastical persons; also certain spiritual courts holden by the bishops in each diocese. At Rome the consistory denotes the judicial court constituted by the college of cardinals. The representative body of the reformed church in France is styled *consistory*. There is now, or should be, according to law, a consistory for every 6,000 Protestant souls, consisting of the pastor or pastors, and from six to twelve elders. The consistory names the pastor. There were in 1863 eighty-eight reformed consistories in France (not including the Lutheran churches).

Consolidated Fund. Down to 1816, the exchequers of Great Britain and Ireland were kept separate, certain portions of the public revenue arising in each kingdom being especially appropriated to the discharge of the interest on its own debts, and other peculiar purposes. But on January 5, 1816, the separate exchequers were consolidated into one; and an Act was at the same time passed consolidating certain portions of the joint revenue of Great Britain and Ireland into one fund, hence called the Consolidated Fund, and providing for its indiscriminate application to the payment of the public debts, civil lists, and other specified expenses of both kingdoms. Some portions of revenue are not included in this fund; but it embraces by far the largest part of the public income. Thus, from March 30, 1859, to March 31, 1860, of a total nett income of 72,912,064*l*., the consolidated fund included no less than 71,089,668*l*.: the expenditure on account of the peculiar charges to be defrayed by the fund during the same year amounted to 31,478,966*l*., leaving a surplus of 41,433,098*l*. applicable to other objects. (Fairman *On the Funds*, 7th ed. p. 196; *Parl. Paper*, No. 347, Sess. 1860, &c.)

Consonance. [Concord.]

Consonant. [Vowel.]

Conspiracy (Lat. conspiratio, *agreement*). In Law, is in the strictest sense an agreement of two or more persons falsely to indict one, or procure him to be indicted, for felony; who, after acquittal, may have his writ of conspiracy. In a more general sense, many species of combinations to injure another are termed *conspiracies*; as to procure one to be arrested, to defraud under certain circumstances, &c. Conspiracy is an indictable offence; and two at least of the persons indicted must be found guilty to produce a conviction, as otherwise the offence is not proved against anyone.

Constable (Fr. connétable, from Lat. comes stabuli, *count of the stable*). A high officer in the monarchical establishments of the middle ages. In France, the first dignitary under the crown, commander-in-chief and supreme military judge. In that country the office was abolished in 1627, as conferring powers too dangerous in the hands of a subject. In England the last permanent lord high constable was Edward Stafford, duke of Buckingham, whose office was forfeited to the crown by his attainder in 1522; since which time it has only been occasionally conferred on particular emergencies. The title is supposed to have originated in the Lower Empire. (Ducange, *Gloss.*)

Constable. In Law. A constable is an officer particularly charged with the preservation of the peace, either within the hundred, where he is called *high constable*, or within the parish or tything, where he is called *petty constable*, and where he has generally superseded the tything-man. The duties of the high constable respecting the preservation of the peace are now merely nominal; but he is still of use to represent the hundred in certain legal actions, and to perform certain ministerial offices connected with the administration of justice, as, for instance, the return of jurors, which originally devolved upon the bailiff of the hundred. The functions of petty constable are still of great and daily importance. It is his business, in the first place, to interfere upon his own authority, and if necessary by apprehension of the offender, whenever a breach of the peace or other more serious offence is committed in his presence, or whenever he has sufficient information of a felony; and, in the next place, to execute all such warrants apparently and upon the face of them legal as shall be committed to his hands by competent authorities. He has a right, when impeded in the execution of his duty, to call upon bystanders for assistance, and has the power in case of sickness or disability to appoint a deputy to execute warrants in his stead. Constables were anciently appointed, and still might legally be so, by the jury of the leet; but high constables are now appointed either at quarter sessions or by the justices of the hundred out of sessions, and petty constables are annually sworn in to the office at quarter sessions for each parish upon presentment of the vestry; and the person so presented is compellable under the penalty of fine and imprisonment, except in recognised cases of disability or exemption, to serve the office. A *special* constable is a person appointed to act as constable upon a particular occasion; and any two magistrates have, in case either of actual or apprehended riot, the power of calling upon all persons who would be liable to serve as petty constables to act as special constables, and their refusal is punishable in the same manner as in the case of the former office.

Constables are frequently appointed in pursuance of particular Acts of Parliament, as the police constables in London. And by 2 & 3 Vict. c. 65, c. 93, and other statutes, a county constabulary was constituted both in England and Scotland.

Constellation (Lat. constellatio, from con, *together*, and stella, *a star*). In order to distinguish with greater facility the different stars, it has been the practice of observers, from time immemorial, to separate them into groups or clusters, which have received the name of *constellations*. These are represented by the figures of men or animals, or other objects to which they were fancied to have some resemblance. Hipparchus called them *Asterisms*; Aristotle and Hyginus, *Bodies*; Proclus, *Animals*; others, *Meteors*; but the term *constellation* has been long established by general usage. The origin of these figures and names is involved in impenetrable obscurity. By most authors the twelve constellations of the zodiac are supposed to have been established about 1,700 years before our era either by the Egyptians or the Chaldeans. Dupuis supposes them to have had an incomparably more ancient origin, and that their names are significative of the climate of Egypt at the epoch when the solstice was in Capricorn; that is, about 15,000 before Christ. But even on this hypothesis, namely, that the names of the zodiacal constellations, or *signs*, as they are frequently called, are significative of the seasons, it may be supposed that reference was made to the sign opposite to the sun, instead of that which the sun occupied; in which case the origin of the names would be referable to an epoch preceding our era by about 2,000 or 3,000 years. This arises from the motion of the equinoctial points, which regress or go backward annually among the stars, accomplishing half a revolution in about 12,500 years.

Hipparchus was the first who constructed a catalogue of the stars from exact observations. It has been preserved to our own times in the *Almagest* of Ptolemy, and contains 1,022 stars distributed among 48 constellations; namely, 12 in the zodiac, 21 to the north of the zodiac, and 15 to the south. Stars which were not comprehended in any of the constellations (and it is evident that there must be many such) were called by a Greek term signifying *unformed*; that is, not entering into the *forms* of the constellations. Several have been added in modern times, as the stars of the southern heavens became better known. A much clearer idea may be formed of the figures and relative positions of the constellations by inspecting a common celestial globe, than from any description, however detailed.

The 48 constellations of Hipparchus are as follow:—

In the zodiac 12: *Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricornus, Aquarius, Pisces.*

In the northern hemisphere 21: *Ursa Minor* (the Little Bear), *Ursa Major* (the Great Bear), *Draco* (the Dragon), *Cepheus, Boötes, Corona Borealis, Hercules, Lyra, Cygnus* (the Swan), *Cassiopeia, Perseus, Auriga* (the Waggoner), *Ophiuchus* or *Serpentarius, Serpens, Sagitta* (the Arrow), *Aquila* (the Eagle), *Delphinus* (the Dolphin), *Equuleus* (the Horse's Head), *Pegasus, Andromeda, Triangulum* (the Triangle).

In the southern hemisphere 15: *Cetus* (the Whale), *Orion, Eridanus, Lepus* (the Hare), *Canis Major* (the Great Dog), *Canis Minor* (the Little Dog), *Argo* (the Ship), *Hydra, Crater* (the Cup), *Corvus* (the Crow), *Centaurus, Lupus* (the Wolf), *Ara* (the Altar), *Corona Australis* (the Southern Crown), *Piscis Australis* (the Southern Fish).

To the above 48 constellations of Hipparchus, 12 near the south pole were added by Bayer, and represented in his *Uranometria*, the first edition of which appeared in 1603. These were: *Indus* (the Indian, or Indian Triangle), *Grus* (the Crane), *Phœnix Apis*, or *Musca* (the Bee), *Triangulum* (the Southern Triangle), *Avis Indica* (the Bird of Paradise), *Pavo* (the Peacock), *Pica Indica* (the Toucan), *Hydrus* (the Hydra), *Dorado, Piscis Volans* (the Flying Fish), *Chameleon*. The two constellations, *Coma Berenices* (Berenice's Hair) and *Antinous*, were formed by Tycho Brahé; the first comprehending some of Ptolemy's unformed stars near *Leo*, and the second including others near *Aquila*. They are given in the catalogue of Riccioli, published in his *Astronomy Reformed* in 1665.

In the *Planisphærium Stellatum* of Bartschius, published in 1624, the eight following constellations are found, and are said to have been formed by the moderns in that part of the heavens which is visible in Europe: *Camelopardalis* (the Giraffe), *Tigris, Jordanus, Vespa* (the Wasp), *Columba Noachi* (Noah's Dove), *Monoceros* (the Unicorn), *Rhombus* (the Rhombus or Rhomboid), *Gallus* (the Cock). The same constellations are met with in the Celestial Charts of Royer, published in 1679, with the exception of *Gallus*. *Vespa* is also changed into *Lis* (the Flower-de-luce), and *Crux* (the Cross) is added.

In the Charts of Hevelius, entitled *Firmamentum Sobiescianum*, and published in 1690, we find 10 new constellations: *Canes Venatici* (the Greyhounds, Asterion, and Chara), *Lacerta* (the Lizard), *Leo Minor* (the Little Lion, in place of *Jordanus*, mentioned above), *Lynx* (instead of *Tigris*), *Sextans* (the Sextant of Urania), *Scutum Sobiescianum* (Sobieski's Shield), *Triangulum* (the Little Triangle), *Vulpecula et Anser* (the Fox and Goose), *Cerberus* and *Mons Mænalus*.

To the above, *Cor Caroli* (the Heart of Charles II.) was added by Flamsteed, and *Robur Carolinum* (the Oak of Charles) by Halley.

Notwithstanding the additions already made to the constellations in the southern hemisphere since the time of Ptolemy, Lacaille found so many clusters of unformed stars, while observing at the Cape of Good Hope, that he added

to the list no fewer than fourteen new constellations, to which he gave the following names: *Officina Sculptoria* (the Sculptor's Workshop), *Fornax Chymica* (the Chemical Furnace), *Horologium* (the Clock), *Reticulus Rhomboidalis* (the Rhomboidal Net), *Cælum Scalptorum* (the Graver), *Equuleus Pictoris* (the Painter's Easel), *Pyxis Nautica* (the Mariner's Compass), *Octans Hadleianus* (Hadley's Octant), *Machina Pneumatica* (the Air Pump), *Circinus* (the Compass), *Quadra* (the Square), the *Telescope*, the *Microscope*, and *Table Mountain.* Some still more recent additions have been proposed, particularly by Bode; among which are the *Honours of Frederick*, the *Sceptre of Brandenburg*, *Herschel's Telescope*, &c.; but they do not seem to be generally used in astronomical catalogues.

If the question were to be asked, What good purpose can be served by this multiplication of arbitrary divisions and fantastic names? we apprehend that no very satisfactory answer could be given. Astronomers doubtless find it convenient to classify the stars under certain divisions; but when the number of divisions becomes so great as to be remembered with difficulty, the advantage disappears. The arbitrary nature of the divisions also leads to great inconvenience, inasmuch as they are liable to much uncertainty, and to frequent change of boundary. Not only have the names in several instances been changed, but it seems to have been a common practice with astronomers and chart-makers to take stars from one constellation and give them to another, without any other rule than that of pleasing their own fancies. On this account it is frequently extremely difficult to identify stars (particularly in the southern hemisphere) in the different catalogues. It is to be wished that the whole of the constellations (excepting perhaps the forty-eight of Hipparchus and Ptolemy) were obliterated from our celestial charts and globes, and that observers in describing the places of the stars would confine themselves to a simple statement of their right ascensions and declinations, at least until some better arrangement and nomenclature shall have been devised and agreed upon.

Constituent Assembly. In French History, the first of the national assemblies of the Revolution; elected in 1788 as the States-General, dissolved in 1791 after proclaiming the constitution of that year.

Constituents of a Matrix or Determinant. [MATRIX and DETERMINANT.]

Constituents of the Roots of an Equation. Algebraists give this name to certain linear functions of the roots which occur in the theory of equations. The equation being of the n^{th} degree, any one, ρ_m, of the $n-1$ constituents of its roots is defined by the formula,

$$\rho_m = x_1 + \omega^m x_2 + \omega^{2m} x_3 \; . \; . \; . \; + \omega^{(n-1)m} x_n,$$

where $x_1, x_2 \, . \, . \, x_n$ are the n roots of the equation, and ω an imaginary n^{th} root of unity. The following relation between any root x_{r+1} and its constituents is easily deducible from the above definition:—

$$n x_{r+1} = \omega^{(n-1)r} \rho_1 + \omega^{(n-2)r} \rho_2 \; . \; . \; + \omega^r \rho_{n-1} + \Sigma x,$$

Σx being the sum of the roots or the coefficient, taken negatively, of the second term of the equation.

Constitution (Lat. constitutio). The collective body of the fundamental laws of a state; either contained in written documents, or established by prescriptive usage. Constitutions have been divided into three kind by political writers: 1. Those granted (octroyées) by monarchs to their subjects; 2. Those springing out of rights enjoyed independently by the people, or classes of the people, which in monarchical countries are recognised by the sovereign in his contract with the people; 3. Those founded on compact between sovereign powers, i. e. federal constitutions. In a certain sense, all states in which the power of a sovereign over his people, or classes of his people, is limited by law or legal usage in any particular, may be said to possess *pro tanto* a constitution; but, in ordinary language, only a government in which the power of legislation, or that of granting and withholding supplies to the sovereign, is vested in the people, or in a body of representatives elected by them or by a class of them, is termed *constitutional.* Constitutions have again been divided into—1. Those in which legislative power is exercised directly by the people (as in some small modern commonwealths, and in all the free states of antiquity); and, 2. Representative constitutions. The last again, as prevailing in modern Europe and America, has been divided historically into—1. Those which have originated from compact between several independent interests, as the sovereign, clergy, nobles, and commons, in feudal kingdoms; 2. Those formed artificially, in modern times, on the model of the British constitution; which, although arising out of the same causes which produced the feudal constitutions, assumed in the course of time a different and more comprehensive character.

Constitutions. In Roman Law, decrees of regular authorities, as prætors, &c.; more particularly decrees of the emperors, whether by decree, edict, or letter.

CONSTITUTIONS, APOSTOLICAL. An ancient code of regulations respecting the doctrine and discipline of the church, said by some to have been promulgated by the Apostles, and collected by Clemens Romanus. They appear to have been at one time admitted into the canon of Scripture. Their authenticity has been a subject of much dispute. They have been printed together with the so-called Canons of the Apostles. (Cotelerii *Patres Apostolici*, vol. i.; Krabbe's *Dissertations on the Apostolical Constitutions and Canons*, Hamb. and Gotting. 1829; Gieseler, *Eccl. Hist.* 1st period, 3rd div. § 66.)

Constitutions of Clarendon. In English History, certain propositions, defining the limits of ecclesiastical and civil jurisdiction, drawn up at the council of Clarendon, near Salisbury,

held by Henry II. A.D. 1164. (Hallam's *Middle Ages*, ch. vii. part ii.)

Constrictor (Lat. constringo, *I squeeze*). A name applied to the larger serpents, which overcome and destroy a struggling prey by throwing themselves round it in overlapping folds, and crushing it by their muscular force. The *Boa Constrictor*, properly so called, is a native of South America.

Construction (Lat. constructio). That branch of the science of Architecture which relates to the practical execution of the works required to carry out the artist's designs. It is immediately connected with the distribution of the different forces, and the strains of the parts and materials of a building, the properties and qualities of the various materials used, and the effects which they are likely to produce in their several places.

Consubstantiation. The term by which Luther expressed the opinion which he held upon the nature of the elements in the Eucharist, as distinguished from *Transubstantiation*, the doctrine of the Romanists. The latter assert, as the word they use implies, that the bread and wine are changed into the body and blood, and lose their former substance, although they retain its appearance miraculously to the senses. The Lutherans deny this change: but affirm that while the bread and wine do still remain in their natural substance, the body and blood are at the same time transfused into them, and thus that both are actually partaken of together.

Consul (Lat.). In Politics, a public officer whose functions partake of the diplomatic and commercial characters. Such officers appear to have been first employed by the Italian republics to protect their merchants engaged in trade in the cities of the Levant. The consuls of European states in that region, and in Africa, are at the present time officers of more importance than those established in the cities of Christendom; as they exercise, according to treaties, civil jurisdiction over the citizens of their respective states. [CONSULAR JURISDICTION.] In general, the consul is not regarded as a minister or diplomatic functionary, and is subject to the civil authorities of the place where he resides. A resident English merchant, acting here as consul of a foreign country, is not exempt from arrest on mesne process. English consuls are now salaried officers, under the Consular Act, 6 Geo. IV. c. 87, and the fees which they are still allowed to take are specified. Much question has been raised as to whether they ought or ought not to be allowed to trade, nor is this susceptible of any general answer under English usage.

Consuls. The supreme magistrates of Rome after the expulsion of the kings. Their number was two, and the period of their office one year; but there was no restriction as to the number of times the same individual might be elected. The power of the consuls was nearly the same as that of the kings; i. e. they were the supreme executive officers, but had no legislative authority. The consuls were originally chosen only from the patricians, but afterwards from the plebeians also. The age required by law was forty-three years; but besides this it was requisite to have passed through the inferior offices of quæstor, ædile, and prætor. They were elected at the Comitia Centuriata, some months before their entrance into office, which took place at different periods of the year at different times, but finally in January. During the interval they were termed *consules designati*, or appointed consuls. Soon after their entrance into office, they cast lots for the provinces to fall to the share of each, the superintendence of which was conferred on them by the senate. Under the emperors the nominal office of the consulate was preserved, but its substantial power destroyed; the elections also became merely forms, the emperor appointing whom he pleased. Then too the custom was introduced of having several sets of consuls in one year; those admitted on the first day, however, gave their name to the year, and were distinguished from the others, who were termed *suffecti* (i. e. substituted), by the title *ordinarii* (i. e. regular). Persons also were sometimes dignified merely with the title without enjoying the office, and were then styled *honorary consuls*. Under Justinian the year ceased to be denominated by the name of the consul.

CONSULS. In French History, were the persons to whom, after the dissolution of the Directory in November 1799, was intrusted the provisional government of the country, and at whose suggestion it was agreed that France should be permanently subjected to consular authority. According to the constitution framed on this suggestion, Bonaparte, Cambacérès, and Lebrun, called first, second, and third consuls, were elected by the conservative senate each for ten years, and invested with different degrees of authority. But the senate having passed various decrees which curtailed the powers of the second and third consuls and augmented those of the first, the government was gradually assimilated to a monarchy, and after the lapse of four years and a half an easy transition was made from the consular to the imperial form; the title of emperor was substituted for that of consul; and the exercise of the sovereign authority, which indeed had been only nominally shared with his colleagues, was delegated exclusively to Napoleon Bonaparte.

Consular Jurisdiction. Under various treaties with foreign countries, British consuls have special jurisdiction, both civil and criminal, over British subjects established in those countries. The most remarkable instances are those of Turkey and China. In the former empire the British consular jurisdiction is of great antiquity, and is now regulated by orders in council, consolidated by that of August 27, 1860, which creates an officer with considerable power (Judicial Assessor at Constantinople) charged with the supervision of its exercise. In China it was established in 1845, after the first

Chinese war, and is administered by a consul-general, subject (in certain cases) to the interposition of the supreme court at Hong Kong.

Consulars. The title given to Roman citizens who had been dignified with the office of consul.

Consultation (Lat. consultatio). In ordinary Legal language, is a meeting of the counsel engaged by a party to a suit, for the purpose of deliberating on the best mode of proceeding in the case.

CONSULTATION, WRIT OF. In Law, a writ granted by the king's court, whereby a cause which had been removed into such court by prohibition out of the ecclesiastical court is returned thither again. It is so called because it issues in consequence of the judges, on consultation, having found that the suggestion on which the prohibition was granted is false or not proved. [PROHIBITION.]

Consumption (Lat. consumptio, from consumo, *I waste away*). This term is commonly applied to a diseased state of the lungs, attended by emaciation, debility, cough, hectic fever, and purulent expectoration. It may be produced by a variety of causes; but hereditary disposition and scrofulous habit are leading causes which predispose to its most alarming form, namely, that which arises from tubercles in the lungs. Its first symptoms are cough; at first dry, but afterwards attended by mucous expectoration, difficult breathing, lassitude, and impaired appetite. These are succeeded by more copious expectoration of viscid or purulent matter, sometimes streaked with more or less blood; greater difficulty of breathing, pain in the side, especially on coughing or taking a full inspiration; and inability to lie with equal comfort upon both sides. The emaciation becomes more perceptible; and the pulse, at first not much affected, becomes full, hard, and quick. Frequent flushings and fever of a remittent character ensue, attended by chills and red sediment in the urine, but the tongue is not much altered, and the mouth is usually moist; the bowels, at first irregular, become habitually relaxed; profuse perspirations, attended by extreme debility and rapid emaciation, follow; the legs swell; and the patient sinks, generally retaining the senses, and even in hope and spirits to the last. In the early treatment of this disease the tendency to inflammatory action must be most cautiously encountered by bleeding, cupping, or blisters; the bowels gently opened by saline aperients; and the cough and irritability quieted by opium, henbane, or hemlock, and by small doses of expectorants. Tonics and acids require to be given with the utmost prudence; and after all, little except palliation can be effected. The diet must from the beginning be scrupulously attended to, and should be mild and nutritive, but not stimulant; and sometimes a temporary benefit results from change of air; but where the disease is once established, its effect is uncertain, and it is in many cases worse than injudicious to advise change of climate. The inhalation of vapours of chlorine and iodine, in very minute quantity, has appeared to give in some cases a little temporary relief; in others it has proved decidedly mischievous; in none, permanently useful; and we must with regret assume that there has been some mistake in the supposed cures of established and constitutional consumption. In its very early periods, change of country, diet, habit, and occupation will sometimes seem to suspend its progress; it has also been checked by other diseases, and not unfrequently it lies dormant in females who breed quickly; but at a later period it again shows itself, and proceeds to its fatal end.

CONSUMPTION. In Political Economy. In the ordinary definition of the science, this term is recognised as one of the three objects of enquiry especially connected with the theory of wealth. Consumption is said to be productive, when it is the result of the employment of capital; and to be unproductive, when neither directly or indirectly it is made to contribute to production. Much of the importance, however, of this distinction, is historical. It gave a colour to many of Adam Smith's reasonings, and perhaps was the prominent cause of his *Enquiry*; but it takes a far less significant position in the modern method of the science.

Contact (Lat. contactus, *a touching*). In Geometry, the term *contact*, as applied to two curves, implies that the latter do not simply intersect, but have two or more *consecutive* points in common. The number of such consecutive common points determines the *order* of the contact. Thus two curves which have two consecutive points in common, are said to have a *two-pointic* contact, or one of the *first* order; if they have three consecutive common points the contact is *three-pointic*, or of the *second* order; if four, *four-pointic*, or of the *third* order; and so on. In short, the number of consecutive common *elements* is equal to the order of the contact. Thus two curves which simply touch each other, or have a common tangent, have a contact of the first order both with each other and with that tangent. If they have the same curvature, they have contact of the second order with each other and with the common circle of curvature. When the number of common points is sufficient to determine one of the curves completely, the order of contact is a maximum, and the latter curve is said to *osculate* the former. [OSCULATION.] Thus a circle is determined by three points, so that we can only demand from it a contact of the second order with any given curve. It is then called the *osculating circle*, or *circle of curvature*. [CURVATURE.] A conic being determined by five points may have contact of the fourth order with any curve of higher order than itself. The determination of such an osculating conic, called also the *conic of five-pointic contact*, has frequently occupied the attention of geometricians. Memoirs on the subject by Cayley, Spottiswoode, and others, will be found in the *Philosophical*

Transactions and most modern mathematical journals. The methods of determining the curve which has contact of a given order with a given curve, are explained in all good treatises on the differential calculus.

The contact and osculation of surfaces is determined by that of their plane sections. On this subject Dupin's *Développements de Géométrie* may be consulted with advantage. Amongst other things, the author there shows that the curvature at any point of a surface is precisely the same as that of any one of the innumerable quadrics which can be drawn to touch the surface at that point, so that its principal normal sections shall have contact of the second order with those of the surface itself. In fact, Euler's and Meunier's formulæ [CURVATURE OF SURFACES] at once show that under these circumstances all sections of the surface and of the quadric, by a plane through their point of contact, will have contact of the second order. The section of this osculating quadric by any plane parallel to the tangent plane of the surface gives at once the *indicatrix*; thence the radii of curvature, conjugate and inflexional tangents, and directions of lines of curvature, &c., are at once determined.

Contact, Angle of. In Geometry, the angle made by a curve line with its tangent. It is also called *angle of contingence* [ANGLE OF CONTACT], and is equal to the *angle of curvature*. Formerly the angle of contact was the subject of much metaphysical controversy amongst geometers. See an excellent account of the writings of Wallis, Peletarius, Clavius, Vieta, and others, on this subject, in the notes to Camerer's *Euclid*, Berlin 1824.

Contact, Stationary. [STATIONARY CONTACT.]

Contagion (Lat. contagio). The propagation of specific diseases from person to person. *Contagious poisons* communicate the property of producing similar poisons; the *small-pox* is a characteristically contagious disease. By some writers the term has been limited to diseases requiring *actual contact* for their communication; but contagious matter appears often transmissible by the air: hence the terms *immediate* and *mediate contagion*. Where diseases are propagated through the medium of the air, they are generally called *infectious*.

Contempt (Lat. contemptus). In Law, disobedience to the rules, orders, or process of a court of competent authority. Contempt in court is punishable by fine or imprisonment: for contempt out of court an attachment may be granted. Contempt of the king's prerogative, by refusing to assist him in the exercise of his lawful authority, &c., is a high misprision or misdemeanour. A breach of privilege of either of the houses of parliament is punishable by that house by censure or commitment, in the same manner as courts of justice punish for contempt. See May's *Parliamentary Practice*, chap. iii., for a full exposition of the law on this subject.

Context (Lat. contextus). The general series of a discourse; when we cite a particular passage, we mean by its *context* the parts immediately preceding and following it, which determine or affect its sense.

Continents (from Lat. contineo, *I hold together*). The large unbroken tracts of land on the earth, whether altogether or entirely disconnected, are included under this name. Thus Europe and Asia together, Africa, North America, South America, and Australia, may all be thus regarded. There is absolutely no natural separation between Europe and Asia: and thus, although in descriptive and political geography they are distinct, in physical geography they are one.

EUROPE AND ASIA occupy a remarkable position in the northern hemisphere. Their shores are deeply indented with inland seas, gulfs, and bays [COAST LINES], and they are flanked by some large and important groups of islands. They include all the most ancient seats and centres of civilisation, with the exception of Egypt, and contain the principal and loftiest mountain chain of the earth, besides many that are subsidiary. Its rivers are not less remarkable; its plains and plateaus are of great extent, and its groups of animals and vegetables eminently important and valuable to the human race. The two AMERICAS, connected by the mighty chain of the Andes, are also strikingly interesting and extremely distinct in all essential peculiarities. AUSTRALIA is equally distinct. AFRICA properly belongs to Europe and Asia, and repeats some of their phenomena, with many that are altogether exceptional owing to its physical condition. Of all parts of the world, the western coast of Europe seems the best adapted to human requirements.

Continental System. In Modern History, the celebrated plan of the Emperor Napoleon for excluding the merchandise of England from all parts of the Continent. It was commenced by the decree of Berlin, issued November 21, 1806, which declared the British islands in a state of blockade, and made prisoners of war all Englishmen found in the territories occupied by France and her allies. The blockade thus instituted was far from complete; and in the course of events licenses were expressly granted by the government for its evasion, and became a source of revenue. It is more than probable that the decree was inoperative from the first. It is certain that Napoleon's soldiers were clothed in British fabrics; and, in effect, the chief value of the expedient has been to show that no precautions can prevent the importation of commodities from one country to another, though they may make it difficult or circuitous.

Contingence, Angle of. [ANGLE OF CONTACT.]

Continual Proportionals. Quantities are said to be continual proportionals, or in continued proportion, when the first is to the second as the second to the third, as the third to the fourth, and so on.

Continued Bass. In Music, the same as *thorough bass*. It receives the name from its continuation through the whole of a composition.

Continued Fraction. An ordinary continued fraction is a complex fraction of the form

$$F = a + \cfrac{1}{b + \cfrac{1}{c + \cfrac{1}{d + \cfrac{1}{e + \&c. \ldots,}}}}$$

a more convenient notation for which is

$$a + \frac{1}{b+}\frac{1}{c+}\frac{1}{d+}\frac{1}{e} + \&c.$$

It is said to be a *terminating* continued fraction when the number of *quotients* a, b, c, d, &c., is finite. It is obvious that any quantity whatever may be expressed in the form of a continued fraction. An ordinary fraction is always expressible in the form of a *terminating* continued fraction, and conversely any part of a continued fraction, breaking off at any quotient, may be converted into an ordinary fraction. Such ordinary fractions are called the *convergents* of the continued fraction, since their values converge towards the value of the continued fraction more and more the greater the number of quotients they embrace. If

$$\frac{A}{A_1}, \frac{B}{B_1}, \frac{C}{C_1}, \ldots \frac{P}{P_1}, \frac{Q}{Q_1}, \frac{R}{R_1}, \&c.$$

be the successive convergents formed by breaking off at the quotients

$$a, b, c \ldots p, q, r, \&c.$$

respectively, we shall have

$$A = a,\ A_1 = 1;\ B = a\,b + 1,\ B_1 = b,\ C = B\,c + A,\ C = B_1\,c + A_1,$$

and generally

$$R = Q\,r + P,\ R_1 = Q_1\,r + P_1;$$

so that the quotients being given and the first two convergents calculated, the rest can be successfully deduced by a very simple and uniform rule. [CONVERGENT FRACTION.]

The numerator or denominator of a convergent has been called by Sylvester a *cumulant*. (*Phil. Trans.* 1853.) It can easily be expressed as a determinant thus—

$$C = \begin{vmatrix} a & 1 & 0 & 0 \\ -1 & b & 1 & 0 \\ 0 & -1 & c & 1 \\ 0 & 0 & -1 & d \end{vmatrix}, D_1 = \begin{vmatrix} b & 1 & 0 \\ -1 & c & 1 \\ 0 & -1 & d \end{vmatrix},$$

the law of which is obvious from inspection. A more concise notation for these cumulants is formed by enclosing their diagonal terms between brackets, thus: $D = (a\,b\,c\,d)$. The successive convergents are alternately greater and less than the continued fraction; they oscillate, as it were, from excess to defect with ever decreasing amplitude. Thus the first is greater than F; the second smaller, but nearer to it than the first; the third again greater, but nearer to F than the second, and so on. The difference between any two convergents $\frac{P}{P_1}$ and $\frac{Q}{Q_1}$ is the fraction $\frac{1}{P_1 Q_1}$, since it can be shown that $P\,Q_1 \sim P_1\,Q = 1$. From this it follows that each convergent is in its lowest terms, and that the error committed by taking $\frac{P}{P_1}$ to represent the continued fraction F must be less than $\frac{1}{P_1\,Q_1}$, and, therefore, à fortiori less than $\frac{1}{2\,Q_1{}^2}$.

A non-terminating continued fraction whose quotients recur is termed a *periodic* or *recurring continued fraction*. Its value can be shown to be equal to one of the roots of a quadratic equation. On the other hand, every quadratic surd gives rise to an equivalent, periodic continued fraction.

Lord Brounker, president of the Royal Society (1670), appears first to have examined continued fractions, the theory of which was afterwards improved by Dr. Wallis, and many other English and Continental writers. Such fractions have many important applications in the theories of equations and of numbers, as may be seen on consulting the works of Euler, Legendre, Gauss, Dirichlet, &c., or the memoir by Sylvester above cited.

Continuity, Law of. A principle of considerable use in investigating the laws of motion, and of change in general, and which may be thus enunciated: *Nothing passes from one state to another without passing through all the intermediate states.* Leibnitz claims the merit of having first made known this law; but in so far as motion at least is concerned, it is distinctly laid down by Galileo, and ascribed by him to Plato. But though a perception of its truth seems to have been felt long before, Leibnitz was certainly the first who applied the principle to test the consistency of theories, or supposed laws of nature. The argument on which he attempted to establish it à priori is, that if any change were to happen without the intervention of time, the thing changed must be in two different conditions at one and the same instant, which is obviously impossible. A remarkable application of the law of continuity was made by John Bernoulli, in an *Essay on the Laws and Communication of Motion* which gained the prize of the Academy of Sciences at Paris in 1724, to prove that perfectly hard bodies cannot exist; because, in the collision of such bodies, a finite change of motion must take place in an instant, an event which, by the law now explained, is impossible. This conclusion was objected to by D'Alembert and Maclaurin, who on account of it were disposed to reject the law of continuity altogether; but the difficulty is got over by supposing (which on various grounds is extremely probable) that there is no real contact, and that bodies begin to act on each other when their surfaces, or what seem to be their surfaces, are yet at a distance.

Continuity, Principle of. In Geometry, is a kind of postulate of immense utility as a mode of discovery. According to it any property of a geometrical figure which has been once established will still hold, though it may possibly have to be differently enunciated and demonstrated, through all the successive states through which the figure may be conceived to pass. Thus since two conics which do not intersect in more than two real points may always be projected into two circles, it is obvious that all *descriptive* properties of two circles, e.g. those concerning their centres of similitude, &c., remain true for the projected conics. The property of intersecting, however, being merely *contingent*, or dependent upon position solely, the principle of continuity teaches that two conics which intersect even in four real points, and which, consequently, cannot be projected into two circles, also possess the descriptive properties in question. The works of modern geometers, since the time of Monge, abound in successful applications of this principle, a discussion of which will be found in the writings of Poncelet (*Propriétés Projectives des Figures*), Chasles (*Aperçu Historique* and *Géométrie Supérieure*) and of several others.

Contorniati. In Numismatics, medals supposed to have been struck about the period of Constantine the Great and his immediate successors; they are of bronze, with a flat impression, and marked with peculiar furrows (Ital. contorni, whence their name). They bear the figures of famous emperors or celebrated men. Their object is uncertain; but they have been supposed to be tickets of admission to the public games of the circus in Rome and Constantinople.

Contour (Fr.; Ital. contorno). In the Fine Arts, the external lines which bound and terminate a figure. The beauty of contour consists in those lines being flowing, lightly drawn, and sinuous. They must be carefully and scientifically drawn; and this cannot be done without a thorough knowledge of anatomy.

Contouring. In Military sketching, signifies describing on paper the form of any piece of ground, or work of defence, by means of drawing outlines of horizontal sections of this ground or work, taken at some fixed vertical interval from each other.

Contraband (Ital. contrabando, *contrary to proclamation*). In Commercial language, goods exported from or imported into a country against its laws. *Contraband of war*: such articles as a belligerent has, by the law of nations, the right of preventing a neutral from furnishing to his enemy. Articles contraband of war are, in general, arms and munitions of war, and those out of which munitions of war are made. All these are liable to be seized: but very arbitrary interpretations have been affixed to the term by powerful states, when able to enforce them by arms. Thus provisions are held contraband of war when it is the object to reduce the enemy to famine. But with respect to these and other articles not in their nature contraband, it seems to be the practice that the belligerent should purchase them from the neutral for a reasonable equivalent, instead of confiscating. Despatches from the ambassadors of a belligerent country to their own government, and from hostile governments to consuls in a neutral country, are also deemed contraband; and so are military and some other persons in the service of a belligerent power. (Phillimore's *International Law*, part x. ch. i.)

Contrabasso (Ital.). Usually called in England the *double bass*. The largest of the violin species of string and bowed instruments, of which it forms the lowest bass.

Contract (Lat. contractus). In Civil Law, the term usually applied to such agreements, whether express or implied, as create, or are intended to create, a legal right, and corresponding liability; such right not attaching to the possession of the subject-matter of the contract, except in equity, and that indirectly, but subsisting both in equity and law against the contracting party.

The conditions essential to the legal validity of a contract relate either to the competency of the parties, the sufficiency of the consideration or inducement, the nature of the thing contracted for, the fairness of the transaction, or, lastly, to the form of the agreement.

And, first, as to the competency of the parties. The party to be sued must have been at the time of the contract of sound mind, and, unless it was for the supply of necessaries, of full age: and if a woman, she must have been unmarried: subject as to the latter condition to some exceptions established either by local custom or by the doctrines of equity.

Secondly, as to the sufficiency of the consideration on the part of the person suing. It must have been either future marriage since performed, or money, or something capable of being estimated in money; or some act, whether of performance or abstinence, whereby some undoubted advantage, though not capable of being exactly valued, accrues to the party sued.

Thirdly, the act contracted for must be neither contrary to written law, nor to public policy; and it must be beneficial to the party seeking either performance or compensation, or to some one on whose behalf he gave the consideration.

Fourthly, there must have been neither fraud (either by concealment or misstatement) nor compulsion on the part of the plaintiff in obtaining the agreement; and fraudulent acts subsequent to the agreement having reference to it are also sufficient to deprive the guilty party of all right under it. Some circumstances are in equity considered either as conclusive evidence of fraud, or as substantive acts of coercion, which are not strictly of such a nature, and are not so deemed at law.

Lastly, as to the form of the agreement. Where it relates to an interest in land of three years' duration or more, or to goods of the

value of 10*l.* or upwards, unless there be earnest or delivery, or where it is an agreement as surety, or where it is upon marriage as a consideration, it must by English law be in writing; though the want of a written instrument may be supplied in equity by partial performance, that is, by acts evidently done in pursuance of the alleged contract.

Contracts are sometimes implied either in the whole from the acts of the parties, as from the ordering of goods a contract is inferred to pay for them; or in part, and as incidental to the principal agreement, as, in the case of a lease, a contract by the tenant to use fairly and take due care of the thing leased. And at law some obligations not arising in any manner from contract are, as regards the mode of enforcing them, placed on the same footing as those which do arise from contract; the remedy, and not the right, being assimilated by statute.

Such are the general requisites to the validity of agreements; but at law the extent of the right and liability arising under them varies according to their form; agreements being there divided into those under seal, which are called agreements by speciality, and those not under seal, which are called simple contract or parol agreements, including not only such as are merely verbal, but such as are written and unsealed. The first sort alone are binding upon the land, and that only when the heir is named; and they possess this further advantage over agreements by simple contract, that being executed as the *deed* of the contracting party, a sufficient consideration will always be implied in their favour, unless an insufficient one be actually stated on the face of them. Again, agreements both by speciality and simple contract are either to pay a sum certain actually stated in the agreement, or a sum uncertain to depend upon the value of the thing received; or they are agreements to perform certain acts. In the first case, the remedy is by action of debt either on bond or covenant, or upon simple contract, as the case may be. In either of the latter cases the remedy is by action for breach of covenant where the agreement is under seal, or by action of assumpsit where it is by simple contract; the relief given in each of the two last-mentioned sorts of action being compensation in damages for the injury accrued from non-performance of the agreement. [Action.]

The remedy in equity, where there is any, is in all cases alike—specific performance of the act agreed to be done; and such relief will be given to the same extent and against the same parties, whether the contracting party himself or his real or personal representatives, without any distinction between agreements under seal and those which are not so.

But though courts of equity have jurisdiction in all cases of agreements, at least in all such as do not constitute an actual debt at law, yet the exercise of that jurisdiction is, subject to certain rules, a matter of discretion; for the reason that the denial of the equitable relief will not leave the party without some remedy, namely, that of damages at law: and on this account specific performance can only be obtained in equity in those cases where pecuniary damages would not afford to the disappointed party an adequate compensation. Thus such relief will not be granted in any of those cases where the inducement to the bargain or agreement was merely the expectation of profit, as it is in agreements for the sale or purchase of personal chattels; and other circumstances also are a bar to equitable relief, which are no defence to an action at law, as, for instance, the want of mutual liability, apparent laches, and indifference in following up the agreement; or particular consequences of collateral hardships arising to one party from actual performance; or the impropriety in equity of the agreement, as where performance would be a breach of trust. And on the other hand, though the equitable jurisdiction is founded upon a supposed legal right, there are cases in which the right having been lost at law, as by default in literal compliance with the terms of the agreement, will yet be enforced in equity.

Contract, Original or Social. In Politics, that which is supposed to exist ab initio, according to some theories of government, between the sovereign power and the subject. So prevalent was this doctrine at the period of the Revolution of 1688, that the Convention Parliament pronounced James II. to have broken the 'original contract between the king and the people.' The original contract, with the reciprocity of rights and duties which it engenders, is clearly a supposition having no historical foundation in the annals of any people; but it is, nevertheless, the only hypothesis in which men can consistently proceed in framing a theory of government which shall satisfy at once the moral and economical wants of society.

Contractility. In Physiology, is the power which certain tissues have, during life, of shortening themselves in a peculiar manner: it is usually observed in muscular and some kinds of fibro-cellular tissue; but is also exercised by a series of cells, as in the *Hydra* polype.

Contradictory Propositions. In Logic, are those which having the same terms differ in quantity and in quality. *Contrary Propositions* are two universals with the same terms, the one negative and the other affirmative. [Proposition.]

Contragredient (from Lat. contra, and gradior, *I go*). Two or more variables are said to be contragredient to as many others when, on replacing those of the first set by linear functions of themselves, those of the second set become replaced by linear functions of themselves respectively inverse (or reciprocal) to the former; in other words, when the new variables, of the one set, bear to the old the same relations that the old do to the new, of the other set. One of the characteristic properties of a set of variables $x, y, z, \ldots$ respectively contragredient to $\xi, \eta, \zeta \ldots$ is that the sum of the

products $x\xi + y\eta + z\zeta + \ldots$ is unaltered by transformation; in other words, this sum is a mixed concomitant of any system of quantics, or a *universal mixed concomitant*. [CONCOMITANT.]

Contralto (Ital.). In vocal Music, the part immediately below the treble; called also the *counter-tenor*.

Contrast (Fr. contraste, Ital. contrastanza). In the Fine Arts, an opposition of lines or colours to each other, so contrived that the one gives greater effect to the other. By means of contrast, energy and expression are given to a subject, even when employed on inanimate forms. All art is indeed a system of contrasts: lights should contrast with shadows, figures with figures, members with members, and groups with groups. It is this which gives life, soul, and motion to a composition. The very principle of harmony or symmetry, in ornamental art, is contrast, one half of a symmetrical figure being the exact opposite or contrast of the other. Any form, or group of lines without meaning in itself, may become when repeated in reverse, or contrasted with itself, a beautiful form, because it at once acquires the elements of symmetry.

Contratenore (Ital.). In Music, the same as CONTRALTO [which see].

Contravallation (Lat. vallum, *rampart*). In Fortification, an intrenchment formed by the besiegers between their camp and the place besieged, to secure themselves and check the sallies of the garrison. The line of *contravallation* is thus, as the name implies, a sort of *counter* fortification.

Contravariant. Any quantic so derived from a given system of quantics as to be equal, in virtue of any unimodular and linear transformations of its variables, to the quantic derived in the same manner from the system to which the given one is transformed by linear substitutions reciprocal or opposite to the first. Thus

$$(bc-d^2, ca-e^2, ab-f^2, ef-ad, fd-be, de-cf \between \xi, \eta, \zeta)^2$$

is a contravariant of the ternary quadric

$$(a, b, c, d, e, f \between x, y, z)^2$$

if x, y, z, and ξ, η, ζ, be understood to be contragredient sets of facients. [CONTRAGREDIENT.] Geometrically the two quantics represent in trilinear coordinates two reciprocal quadric curves. Any invariant of the system consisting of a quantic

$$(* \between x, y, z \ldots)^n$$

and a linear function

$$x\xi + y\eta + z\zeta + \ldots\ldots,$$

formed on the hypothesis that $\xi, \eta, \zeta \ldots$ are constants, is a contravariant of the n-ic when these constants are treated as facients contragredient to $x, y, z \ldots$.

Control, Board of, or **Board of Commissioners for the Affairs of India.** Was constituted under the authority of Mr. Pitt's celebrated Act, passed in 1783, as a check on the political power of the East India Company, and continued to act until the abolition of that power in 1858.

Controller (Fr. contrôleur). An officer appointed to control or oversee the accounts of other officers, and to certify whether the matters confided to his care have been controlled or examined. In England, there are several public functionaries of this title, as the Controller of the Mint, Customs, Stationery, &c.

Contumacy (Fr. contumace, Lat. contumacia). In Civil and Ecclesiastical Law, a wilful disobedience to any lawful summons or judicial order. The term is in use in the law of Scotland and of France. In that of England it was significant only in connection with EXCOMMUNICATION [which see].

Conus (Lat.). The name of a Linnæan genus of *Vermes Testacea*, characterised by the conical form of the shell, the base of which is formed by the spire, which is accordingly flat, or very slightly projecting; the aperture is narrow and rectilinear, or nearly so, without any enlargement or plication. The genus is retained without subdivision, and forms, with *Pleurotoma*, *Lachesis*, and *Terebra*, the family Conidæ of the Pectinibranchiate order of Gastropods in the system of Woodward.

Convent (Lat. conventus, from convenio, *I come together*). A religious house, inhabited by a society of monks or nuns. [MONACHISM.]

Conventicle (Lat. conventiculum, dim. of conventus). An assembly for the purpose of divine worship; first used in a contemptuous sense for the meetings of the followers of Wicliffe (stat. 2 Hen. IV. c. 15), and since applied to the places of meeting of petty sects and of Dissenters in general in the Conventicle Act 16 Ch. II., repealed by 52 Geo. III. c. 155. Originally the word had no such peculiar application, but was used by the fathers and ancient writers for a church.

Convention (Lat. conventio). In Political language, this name has been applied to assemblies of national representatives meeting on extraordinary occasions without being convoked by the legal authority. Two parliaments have been so called in English history. The first, that which met in April 1660, and restored Charles II. to the throne—the Lords assembling by their own authority; and the Commons, by virtue of writs issued in the name of the keepers of the liberties of England, by the authority of parliament. The second, that which met in 1688, each house by its own authority and on the summons of the prince of Orange, and declared that King James II. had abdicated the crown, which was transferred to William and Mary. In French History, the name *convention* is applied to that assembly which met after the legislative assembly had pronounced the suspension of the royal functions, in September 1792, and proclaimed the republic at its first sitting. This body dissolved itself on the establishment of the Directory, in October 1796. The Scottish assembly which met on the flight of James II. was entitled the Convention of Estates. In the United States, meetings of the people of separate states by specially chosen representatives, to

review and amend the state constitutions, have been termed *conventions.*

CONVENTION. In the language of Diplomacy, is generally used as synonymous with *treaty.* Contracts between belligerents as to certain rules to be adopted on both sides in carrying on the war are technically termed *general conventions.*

CONVENTION, MILITARY. A treaty between military commanders concerning terms for a temporary cessation of hostilities; generally between a victor and a defeated general, for the evacuation of a district or position by the latter. Such, at least, were the two most celebrated conventions of modern times: that of Closter-Seven (1757), between the dukes of Cumberland and Richelieu; that of Cintra (1808), between Junot and the English generals.

Convergent Fraction. The ordinary fraction which is equal to any portion of a continued fraction obtained by neglecting all that follows any particular quotient. Thus,

$1,\ 1+\frac{1}{2}=\frac{3}{2},\ 1+\frac{1}{2+}\frac{1}{3}=\frac{10}{7},\ 1+\frac{1}{2+}\frac{1}{3+}\frac{1}{4}=\frac{43}{30}$ &c.

are three successive convergents of

$$1+\frac{1}{2+}\frac{1}{3+}\frac{1}{4+}\frac{1}{5+}\frac{1}{6}\ \&c.$$

[CONTINUED FRACTION.] To obtain the numerator (or denominator) of any convergent corresponding to a certain quotient, multiply the numerator (or denominator) of the preceding convergent by that quotient, and to the product add the numerator (or denominator) of the next preceding convergent. Thus $43=10\times 4+3$.

Convergent and Divergent Series. An infinite series is said to be *convergent* when, however many of its terms may be added together, the sum never exceeds, numerically, some finite quantity. On the other hand, it is said to be *divergent* when, by adding a sufficient number of terms, a sum can be obtained which numerically exceeds any given finite quantity, however great. A series is not necessarily convergent when its terms continually decrease in magnitude; for instance the series $1+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}$ &c. is divergent. If, however, besides decreasing numerically, the terms have alternate signs, the series will be convergent; thus, $1-\frac{1}{2}+\frac{1}{3}-\frac{1}{4}$ &c. is convergent. A series will be convergent if the quotient obtained by dividing each term by the preceding one is numerically less than some assignable *proper* fraction, or if this property obtains from and after a certain term. On the other hand, the terms being all of the same sign, the series will be divergent if the quotient in question is equal to or greater than unity. This test of convergency and divergency cannot be always applied, however, and recourse must be had to others. For instance, the ratio of the n^{th} to the $(n-1)^{th}$ term of the series $1+\frac{1}{2}+\frac{1}{3}$ &c. . being $\frac{n-1}{n}$, is always less than 1, but no proper fraction can be *assigned* than which it is always less, for it approaches unity without limit as n increases. The series is, in fact, divergent; for the third and fourth terms are together greater than $\frac{2}{4}$, the four following terms are greater than four times the last or $\frac{4}{8}$, the eight following terms are together greater than $\frac{8}{16}$, and so on, so that the whole series has a greater sum than $1+\frac{1}{2}+\frac{1}{2}+$ &c. . . . which is manifestly divergent. For further details on this subject, see Cauchy's *Cours d'Analyse*; *Penny Cyclopedia*; *Encyclopædia Metropolitana*, art. 'Calculus of Functions;' Catalan's *Traité Élémentaire des Séries*, Paris 1860, &c.

Convergent-nerved. In Botany, a term used in describing the venation of leaves, to denote cases where the ribs form a curve and meet at the point, as in *Plantago lanceolata.*

Converse of a Proposition. In Mathematics, is another proposition which has for its hypothesis and predicate, respectively, the predicate and hypothesis of the original proposition. Thus the converse of Euclid's fifth proposition, first book, wherein it is affirmed that if two sides of a triangle be equal, the opposite angles will also be equal, is, If two angles of a triangle be equal, so also will be the sides opposite to these angles. The converse of a proposition is not necessarily true, and consequently requires demonstration. Euclid generally establishes his converse propositions indirectly, that is to say by a *reductio ad absurdum.*

Conversion (Lat. conversio). In Logic, a proposition is said to be *converted* when the terms are so transposed that the subject is made the predicate, and vice versâ. All logical conversion is illative; i.e. the truth of the converse follows from that of the original. Conversion is either *simple* or *per accidens.* Universal negatives (denoted by the sign E) and particular affirmatives (I) can be converted simply, retaining both quantity and quality: thus, 'No virtuous man is a rebel;' 'No rebel is a virtuous man.' Conversion per accidens changes either quantity or quality. Universal affirmatives (A) are converted by changing the quantity; as, 'All oaks are trees;' 'Some trees are oaks.' Particular negatives (O) are converted by changing the quality, considering the negative as attached to the predicate instead of the copula; the proposition is thus changed into I, 'Some poets are not learned;' 'Some not learned (unlearned) men are poets.' [PROPOSITION.]

Convert. A person who changes his religion. Persons, of what faith soever, who abandon their own creed and embrace Christianity are called *converts,* in contradistinction to *apostates,* applied generally to *Christians* who adopt another religion.

Convex. [CONCAVE AND CONVEX.]

Conveyance (from *convey*). In Law, a deed which passes land from one to another. [REAL PROPERTY, LAW OF.] *A conveyancer* is a lawyer whose business consists in advising and preparing such deeds. It is not necessary to be called to the bar to practise as a conveyancer; but most conveyancers take that step soon after beginning their business, and frequently combine it with that of equity draftsmen.

Conviction (from Lat. convinco). At Common Law, is the finding of one guilty of an offence by the verdict of a jury; and may take place where one is outlawed, or appears and confesses, or is found guilty on the inquest. [JURY; VERDICT.] By various statutes summary proceedings, without the intervention of a jury, are authorised for the trial and conviction of minor offenders. Such are those before commissioners of excise, &c., for breaches of the revenue laws, and before justices of the peace for various disorderly offences. The party charged must be summoned to attend; and a conviction by a magistrate must be in writing, and should state the whole of the evidence for and against the defendant.

Convocation (Lat. convocatio). In English Ecclesiastical Law, the council of the church, derived, first, from the custom of the bishops assembling their diocesan clergy for the sake of considering spiritual matters; and, secondly, of the archbishops holding convocations of the clergy of a whole province. Convocations were first assembled in England under the king's authority by Edward I., who summoned them by their provinces, for the sake of obtaining subsidies from the clerical body. They met in each province in two houses—one, of the suffragan bishops; the other, of deans, archdeacons, and representatives of the inferior clergy. The taxation of their own body was withdrawn from convocation in 1664; and, on the other hand, the privilege of voting for knights of the shire was then conceded to ecclesiastics. As the power of enacting canons had been already virtually abolished by statutes of Henry VIII., Elizabeth, and Charles II., there now remained no business for convocation to transact; and it was only in the reigns of William III. and Anne, when attempts were made by the high church party to impart fresh activity to it as an ecclesiastical tribunal, that its meetings were attended with any historical importance. After that period it became customary to prorogue convocation every year immediately upon its assembling. Within the last few years it has become the practice for the crown to allow convocation to sit and transact business for some days at the commencement of every session of parliament. Committees have been appointed for reporting upon church grievances or abuses, and their reports and recommendations have been discussed in both houses. No legislation has hitherto issued from these proceedings. The rights and history of the convocation are treated of at length in several writings of the learned Bishop Gibson, especially his *Synodus Anglicana*, Lond. 1702.

CONVOCATION, HOUSE OF. In the university of Oxford, is the assembly which ratifies decrees and statutes. It is composed of all members of the university who have at any time been regents [REGENTS], and who, if independent members, have retained their names on the books of their respective colleges. No proposition can be entertained in convocation unless it has been first submitted to the Hebdomadal Council, or Congregation, by whom it must be in the first instance sanctioned or rejected.

Convolutions (from convolutus, part. of convolvo, *I roll together*). In Anatomy, the winding folds of the superficial layer of the brain; and also the coils and turns of the intestinal tube.

Convolvulaceae (Convolvulus, one of the genera). A natural order of herbaceous or shrubby Exogens, twining and producing a milky juice when wounded. They are very abundant in the tropics, and possess purgative qualities in their roots, depending upon a peculiar resin, of which scammony and jalap, yielded by the *Convolvulus Scammonia* and *Exogonium Purga*, may be taken as examples. Many of these plants are objects of striking beauty. Some, which unfold their pure, white, magnificent flowers at night only, are called in tropical countries Belle de Nuit; others expand only beneath a warm and brilliant sunshine. The *Lignum Rhodium* of the old pharmacologists is produced by an upright bushy species, called *Convolvulus* or *Rhodorrhiza scoparia*. They belong to the Solanal alliance, and have monopetalous corollas, five free stamens, a basal placenta, and leafy doubled-up cotyledons.

Convoy (Fr. convoyer, *to conduct*). In Navigation, the term applied to designate a ship or ships of war, appointed by government or by the commander-in-chief on a particular station, to escort or protect the merchant ships proceeding to certain ports. Convoys are mostly appointed during war; but they are sometimes also appointed during peace, for the security of ships navigating seas infested with pirates. For an account of the various regulations and conditions relative to convoys, see M'Culloch's *Com. Dict.*

CONVOY. In the Military service, signifies a detachment of troops appointed to guard supplies of provisions, ammunition, or money, in their progress to a distant part of any country, or to an army in the field, against an attack which might be made upon them either by the peasantry or by parties of the enemy.

Convulsion (Lat. convulsio, from convello, *I pull together*). A writhing and agitation of the limbs, and involuntary action of the muscles in general. The fits vary much in extent and violence, sometimes attacking the whole body, and at others confined to particular parts; in the former case the mind is affected, but in the latter it often remains undisturbed; they also vary in duration, lasting from a few minutes to some hours. They are sometimes preceded by dizziness, double or disturbed vision, and coldness, and are followed by great languor; but at others they come and go without much disturbance. Teething, worms, and overloaded bowels are common causes of convulsive attacks in children; and these are relieved by freely and timely lancing the gums, and by the adminis-

tration of proper purges. In *puerperal convulsions*, bleeding and opiates are the usual remedies; and in cases where convulsive attacks arise from violent affections of the mind, the exciting causes must be studiously avoided. Warm baths, bleeding, and nervine stimulants are the usual medical aids; and where there is difficulty of swallowing, a glyster, composed of half a pint of gruel with a drachm of tincture of opium and two drachms of tincture of assafœtida, has, in adults, proved eminently useful. Cold affusions often do harm. The after-treatment consists in the judicious use of tonics and nervous stimulants, and in avoiding all obvious exciting causes.

Cooler. An apparatus used by brewers and distillers for cooling worts. The coolers generally consist of very shallow vessels exposing great surface, and placed in the high and airy parts of the brewery; the cooling is sometimes assisted by fans, which agitate the air over their surfaces. Worts are also occasionally cooled by causing them to traverse metal pipes, which are surrounded by a countercurrent of cold water.

Cooperation. The association of two or more persons in some industrial process. If the labour undertaken is of the same character, as that of two men sawing timber, the cooperation is said to be *simple*; if the parties are engaged in different occupations, all of which, however, tend to one result, as is the case with the very numerous workmen who contribute towards the manufacture of a watch, the cooperation is called *complex*. It is by such a cooperation that the division of labour is made most effectual.

Of late years this word has been employed in a different but analogous sense: viz. for the association of workmen and others, either for the purpose of distributing commodities in the manner of retail trade, or for actual manufacture. The latter is becoming very common in Continental towns: the former has been successfully attempted in the north of England; and in some cases workmen have associated with a view to engaging in production.

In cooperation of this kind, capital and labour are united in the same persons. The capital is subscribed by the workmen, and the subscriber works in the occupation for which the capital is employed. Or in case the capital is employed for trade, a fixed sum is generally paid as interest on the amounts subscribed, and the remaining profits are divided according to the evidence of consumption. Generally the purchaser of articles at a store or shop of this description receives a tally or token; and when a division of profits takes place, can claim out of the accumulations a sum proportioned to the number of tokens or tallies produced. In almost all cases, the rule is to give no credit for goods supplied.

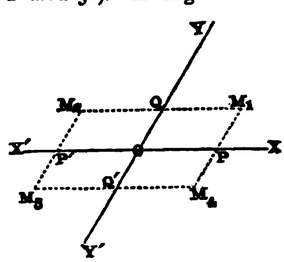
The association at Rochdale known by the name of 'the Equitable Pioneers,' is that which is most commonly cited as one of the earliest and most successful of these combinations. The origin of the scheme was the failure of the local savings-banks. It is said that, beginning with a wheelbarrow full of goods, the business done at this 'store' in 1864 reached nearly 200,000*l*.

Cooperative societies are in general looked on by economists and philanthropists with a very favourable eye. The system appears likely to harmonise, or at any rate to throw great light on the mutual and apparently conflicting interests of labour and capital, and ultimately to form a practical refutation of some among the worst features in the action of trades unions and other combinations of workmen and employers more or less coercive and irritating. The moral effects of such associations are more obvious. They inculcate economy, freedom from indebtedness, and the best forms of self-respect and honest independence. Nor are they less useful (the cooperation taking the form of retail trade) in obviating the practice of adulterating commodities which we are told prevails to so serious an extent among many shopkeepers, especially those whose business lies chiefly with working people. As the dealers are also the buyers, the interests of honesty are thus on the side of the shop, and the motives to adulteration are eliminated. No man would willingly sell himself inferior, disguised, or unwholesome commodities.

It is not quite clear whether the cooperative system can be made to apply to production with as much safety and success as it does to consumption. There is greater complication in the business, more risk of mismanagement, and the necessity arises of adopting the credit system of ordinary business. But the experiment has been tried and has not hitherto failed. It is acknowledged that on the Continent the success has been continuous, and that the condition of the workmen has been materially improved where the system is adopted. Similar testimony is given on the whole to the working of cooperation for production in this country, in so far as its effects have hitherto been estimated.

Cooperative Stores. [COMBINATION.]

Coordinates (Lat. con, *together*, and ordino, *I arrange*). In Algebraic Geometry,



the system of magnitudes by which the position of a point is determined. Of the many systems of coordinates now in use, the most important are distinguished as *Cartesian* (rectangular and oblique), *polar*, *trilinear*, *triangu-*

lar, quadriplanar, tetrahedral, three-point, four-point, elliptic, spherical, &c.

In the *Cartesian* system, the invention of which by Descartes marked one of the greatest epochs in the history of mathematical science, two fixed right lines or *coordinate axes* are assumed, one of which XX′ is usually distinguished as the *abscissa axis* and the other YY′ as the ordinate axis; the point O in which they intersect is termed the *origin of coordinates*, the coordinates themselves, of any point in the plane, being the lengths of the segments intercepted upon each axis between the other axis and a parallel to the latter through the point in question. To distinguish between the four points M_1, M_2, M_3, M_4, which according to this would have the same coordinates, the latter are regarded as positive or negative according as the corresponding intercepts fall on one or the other side of the origin. The intercept on the abscissa axis OX is called the *abscissa* of the point in question and denoted by x, that on the ordinate axis OY its *ordinate* and represented by y. Innumerable points may be found whose coordinates will satisfy any given equation in x and y. The curved line on which all such points lie is called the *locus of the equation*, and the latter in its turn is termed the *equation to the curve*. If the equation is of the first degree in x and y, the locus is a right line; if of the n^{th} degree, every right line will cut the locus in n points; in other words, the latter will be a curve of the nth order. To render the equations homogeneous, and thus secure greater symmetry, the coordinates x and y are frequently expressed as ratios $\frac{x}{z}$, $\frac{y}{z}$, where z may be regarded as the symbol for the linear unit.

In a similar manner to determine a point in space by the *Cartesian system*, three fixed lines OX, OY, OZ (*coordinate axes*) meeting in a point O (the *origin*), and determining three distinct planes XOY, YOZ, ZOX (*coordinate planes*) are assumed, and the coordinates of any point are the intercepts, positive or negative, determined on each axis by two parallel planes, one of which passes through the other two axes, and the other through the point in question.

Polar Coordinates.—In this system a fixed *initial line* or polar axis OX is assumed, one extremity O of which is called the *pole*. The *polar coordinates* of any point M in the plane are then the *radius vector*, $OM = r$ or distance of the point from the pole, and the *vectorial angle* $MOX = \theta$, which latter is regarded as positive or negative according to the direction in which the initial line must rotate in order to coincide with the radius vector. To determine a point in space by means of polar coordinates, it is necessary to assume as fixed elements a *pole* O, an *initial line* OZ through the pole, and an *initial plane* OZX through this line. The polar coordinates of any point M are then the *radius vector* $MO = r$, the *plane vectorial angle* $MOZ = \theta$, and the dihedral angle ϕ between the *vectorial* and *initial* planes MOZ, XOZ.

Trilinear Coordinates of a point M are the lengths α, β, γ of the perpendiculars let fall from the point upon the sides, opposite to the angles A, B, C of an assumed and fixed *fundamental triangle* or *triangle of reference*. It is to be observed that the trilinear coordinates of every point in the plane satisfy the relation

$$a\alpha + b\beta + c\gamma = 2\Delta,$$

where a, b, c, Δ represent, respectively, the sides and area of the triangle of reference. In virtue of this relation all equations may be rendered homogeneous, and thereby all the advantages of symmetry secured in the analytical treatment of geometrical questions.

Triangular Coordinates of a point in a plane are the ratios to the triangle of reference of the three triangles which have its sides for bases, and the given point for common vertex. The triangular coordinates x, y, z of any point in the plane obviously satisfy the relation

$$x + y + z = 1.$$

Quadriplanar Coordinates of a point in space are the lengths α, β, γ, δ, of the perpendiculars let fall from that point upon the faces, opposite to A, B, C, D, of a fixed *fundamental tetrahedron* or *tetrahedron of reference*. The quadriplanar coordinates of every point in space will satisfy the relation

$$A\alpha + B\beta + C\gamma + D\delta = 3V,$$

where V is the volume of the tetrahedron of reference, and A, B, C, D the areas of its faces.

Tetrahedral coordinates of a point in space are the ratios to the tetrahedron of reference of the four tetrahedra which have the faces of the former for bases and the point in question for common vertex. The relation

$$x + y + z + w = 1$$

is satisfied by the coordinates of every point in space.

Tangential Coordinates.—In the Cartesian system a point is determined by its coordinates x, y, and a line by any linear relation between these coordinates, such as

$$\xi x + \eta y + z = 0,$$

or rendered homogeneous by putting for x and y the ratios $\frac{x}{z}$, $\frac{y}{z}$,

$$\xi x + \eta y + \zeta z = 0.$$

In the tangential system, on the other hand, a line is determined by two coordinates, and a point by a linear relation between the same. In fact the above plane is perfectly determined by the ratios $\frac{\xi}{\zeta}$, $\frac{\zeta}{\eta}$, which denote, in fact, the reciprocals, taken negatively, of the intercepts on the axes between the origin and the line in question. It can easily be shown that if η, ξ, ζ satisfy any linear homogeneous equation, the corresponding lines will all pass through a point whose Cartesian coordinates x, y, z are proportional to the coefficients of that equation.

Thus according as x, y, z or ξ, η, ζ are regarded as variable,

$$\xi x+\eta y+\zeta z=0$$

may be interpreted as the Cartesian *equation of a line* whose tangential coordinates are ξ, η, ζ or as the tangential *equation of a point* whose Cartesian coordinates are x, y, z. Just as in the Cartesian system a homogeneous equation of the n^{th} degree in x, y, z represents a curve of the n^{th} order, since by the theory of equations there are n values of x, y, z which simultaneously satisfy this equation and that of any *line*

$$\xi x+\eta y+\zeta z=0,$$

so in the tangential system a homogeneous equation of the n^{th} degree in ξ, η, ζ represents a curve of the n^{th} class, since there are, in general, n distinct values of the coordinates ξ, η, ζ which satisfy, simultaneously, the equation in question and that of any *point*

$$\xi x+\eta y+\zeta z=0.$$

From the foregoing the meaning of tangential coordinates in space will be at once evident.

Three-point Coordinates of a line are the lengths of the perpendiculars α, β, γ, let fall upon the line from the vertices A, B, C of the fundamental triangle. Between the coordinates α, β, γ of any line whatever exists the relation

$$a^2\alpha^2+b^2\beta^2+c^2\gamma^2-2\,b\,c\,\beta\,\gamma\cos A-2\,c\,a\,\gamma\,\alpha\cos B-2a\,b\,\alpha\,\beta\cos C=4\,\Delta^2,$$

where a, b, c, A, B, C, Δ represent the sides, opposite angles, and area of the fundamental triangle.

Four-point Coordinates of a plane are the lengths of the perpendiculars from the vertices of the fundamental tetrahedron upon that plane.

Elliptic Coordinates.—Through any point in a plane two, and only two, quadrics confocal with a given one can be drawn, and conversely two quadrics confocal with a given one may be said to determine, by their intersection, the position of any point in the plane.

Two such quadrics, one of which is always an ellipse and the other a hyperbola, are of course defined by the magnitudes of their respective major-axes; so that the latter may be said to determine the position of a point on the plane. These major-axes, or suitable functions of the same, are termed for this reason the elliptic coordinates of the point in question. In a similar manner the elliptic coordinates of a point in space are the major-axes, or certain functions of the same, of the three quadrics confocal with a given one which intersect in that point. Thus, whatever value λ may have, the quadric

$$\frac{x^2}{a+\lambda}+\frac{y^2}{b+\lambda}+\frac{z^2}{c+\lambda}=1$$

will be confocal with

$$\frac{x^2}{a}+\frac{y^2}{b}+\frac{z^2}{c}=1,$$

and the three roots of the cubic equation in λ will determine the three confocal quadrics, an ellipsoid and two hyperboloids, which intersect in the point (x, y, z). These three values of λ are usually considered as the elliptic coordinates of the point in question. [CONFOCAL QUADRICS.] In pure and applied mathematics the use of elliptic coordinates often secures elegance, simplicity, and symmetry. In every good treatise on algebraic geometry and the calculus, therefore, full details will be found. The subject has been recently treated with great skill by Hesse in his *Vorlesungen über Analytische Geometrie des Raumes*, Leipzig 1861.

Elliptic coordinates are themselves merely particular cases of far more general systems, where, for instance, a point in space is defined by the values of three parameters which determine the three individuals, of as many systems of given surfaces, which intersect in that point. The choice of the three systems of surfaces will depend, of course, upon the nature of the investigation.

Spherical Coordinates.—Points on a sphere may obviously be determined in a similar manner to those on a plane; arcs of great circles in the former case taking the place of segments of right lines in the latter. To each system of coordinates in a plane will correspond therefore a system of coordinates on a sphere; these are called *spherical coordinates*.

Coordinates, Transformation of. The passage by algebraic substitution from one system of coordinates to another is frequently required in geometrical investigations, and the formulæ necessary for so doing are, in the cases of ordinary coordinate systems, given in all treatises. The general method pursued is to establish a sufficient number of equations by whose solution the coordinates of a point in one system may be expressed as functions of the corresponding coordinates in the other. Thus the passage from Cartesian to trilinear coordinates is effected by means of the system of linear equations,

$$a\,x+b\,y+c\,z=\alpha,$$
$$a_1x+b_1y+c_1z=\beta,$$
$$a_2x+b_2y+c_2z=\gamma,$$

where the equations obtained by putting the trilinear coordinates $\alpha=\beta=\gamma=0$ are the Cartesian equations, rendered homogeneous, of the sides of the triangle of reference in the trilinear system.

Copaiba or **Copivi Balsam.** An exudation from the *Copaifera officinalis*, a South American tree; it is a liquid resin, and yields by distillation a considerable quantity of a pungent volatile oil. It is used in medicine chiefly as a diuretic.

Copal (an American name applied to clear gums). This substance is often improperly called *gum copal*. It is a peculiar resin, very difficultly soluble in alcohol; hard, brittle, and inodorous: its specific gravity varies from 1·04 to 1·13. It is the produce of the *Rhus copallina*. Brazilian Copal is the product of several species of *Hymenæa*, and of *Trachylobium Martianum*. Indian Copal is produced by *Valeria indica*. Another kind of copal is also brought

from the coast of Guinea. It is used in varnishes.

Copaline or **Highgate Resin.** A fossil resin found in irregular pieces of a brown colour, resembling copal. It was originally discovered in the London clay of Highgate Hill.

Coparcenary (Lat. con, and particeps). In Law, an estate is said to be held in coparcenary, the tenants being termed *coparceners*, where it descends from an ancestor to two or more persons. Sisters are coparceners at common law; tenants in gavelkind by common law in Kent, and by the *custom of the manor* in some other localities. No right of survivorship exists between coparceners. They may agree, or anyone may force the rest to make partition.

Copernican System. The system of Astronomy propounded by Copernicus. It affirms the sun to be at rest in the centre, while the planets revolve round it. [ASTRONOMY; PTOLEMAIC SYSTEM.]

Copernicia (after Copernicus the astronomer). Tropical American palms, with tall stems and fan-shaped leaves. *C. cerifera*, the Carnaüba Wax Palm of Brazil, has a very hard trunk, forty feet high and six or eight inches thick, commonly employed for building purposes. The young leaves are coated with wax, called *Carnaüba wax*, harder than bees-wax and of a lemon tint, which has been employed for candle-making.

Copiapite or **Yellow Copperas.** A hydrated sesquisulphate of iron, occurring in the district of Copiapo in Chili. [FIBROFERRITE.]

Coping. In Architecture, the upper covering, or top course of a wall, usually of stone, and wider than the wall itself, in order to let the rain-water fall clear of the wall: in brick walls the coping is often executed with a course of plain tiles, and brick laid upon it on edge and bedded in cement.

Copper (Lat. cuprum; Ger. kupfer). This metal was known at a very remote period; and in the early ages of the world, before iron was in use, copper was the chief ingredient in domestic utensils and instruments of war. It is an abundant metal, and is found native, and in many ores; of these the most abundant are the varieties of *pyrites*, which are sulphides of copper and iron. The richest British mines are those of Cornwall, but it is also abundantly produced in North and South America, in Australia, and elsewhere. A mass of native copper weighing 500 tons is said to have been found in the mines of Lake Superior. Copper is distinguished by its colour. Its specific gravity is 8·9. It is ductile and malleable, and requires a temperature somewhat lower than gold, but higher than silver (estimated somewhat above 2,000° Fahrenheit) for its fusion. Exposed to air and moisture, copper gradually becomes covered by a green rust: when heated red hot, it absorbs oxygen, and is superficially converted into a black oxide, which is the basis of the principal salts of copper: it consists of 32 copper and 8 oxygen. It forms blue or green salts with the acids; of these the *sulphate of copper*, or blue vitriol, is a good example. The salts of copper are poisonous; and in consequence of the use of copper vessels for culinary purposes, food is sometimes contaminated by them. It is detected when in very minute quantities by the bright blue colour produced by the addition of liquid ammonia, and by a brown precipitate with ferrocyanide of potassium. A clean slip or wire of iron dipped into a solution containing copper becomes covered with the latter metal, in a metallic state.

Commercial copper is never perfectly pure, but almost always contains traces of silver, arsenic, and bismuth, which interfere more or less with its malleability and ductility. Among the alloys of copper, those with tin (bronze and bell metal) and with zinc (constituting the varieties of brass) are the most important. Standard gold and silver are also alloys of those metals with copper.

Copper Glance or **Vitreous Copper-ore.** A native disulphide of the metal, containing when pure about 80 per cent. of copper.

This ore occurs massive and crystallised in six-sided prisms. Its colour is grey with a metallic lustre; but the surface is sometimes dull, or iridescent. It is sectile and breaks with a conchoidal fracture.

Copper Glance is one of the richest ores of copper, and forms veins and beds together with Copper Pyrites, Malachite, &c.

Copper Nickel. Native di-arsenide of nickel, composed of about 60 per cent. of arsenic and 40 nickel, with small quantities of antimony, cobalt, lead, iron and sulphur. It occurs crystallised and massive. The colour is copper-red. It emits an arsenical odour when struck with steel; and breaks with a conchoidal fracture.

Copper Pyrites or **Yellow Copper-ore.** A double sulphide of copper and iron, composed of about 35 per cent. of sulphur, 35 of copper and 35 iron.

It occurs crystallised in tetrahedrons, and stalactitic, mammillated, and amorphous. When pure, the colour of a newly fractured surface is bright brass-yellow with a metallic lustre. Frequently the surface displays variegated tarnish; it is then called *Peacock-ore*.

Copper Pyrites occurs in lodes or beds, with other ores of copper, lead, and iron, in rocks of various geological ages, but generally in primary and metamorphic rocks. It is the most abundant ore of copper in England.

Copper Schaum or **Copper Froth.** [TYROLITE.]

Copper Slate. [KUPFER-SCHIEFER.]

Copper Uranite. [CHALCOLITE.]

Copper Vitriol. [CYANOSITE.]

Copperas or **Green Vitriol.** Hydrated protosulphate of iron, composed of 28·9 per cent. of sulphuric acid, 25·7 protoxide of iron, and 45·4 water. This salt, which is largely manufactured for commercial purposes, also occurs *native*, and is generally produced by the

decomposition of Iron Pyrites. It is used in dyeing, and in the manufacture of writing-ink, Prussian blue, &c. It effloresces when exposed to air, absorbs oxygen, and becomes of a reddish colour, whence the French term, *Couperose*, corrupted into *copperas*.

Coppice (Old Fr. copeiz). Woods which are cut down at stated periods to be manufactured into poles, rods, stakes, faggots for fuel, bark for the tanner, or charcoal. When wood of this kind has no standard trees, it is called simply a *coppice* or *copse wood*; but when it has standard trees interspersed through it, it is called a *wood*. When coppices are cut down for hoops, rods, and small stakes for manufacturing into crates, hoops, wicker hurdles, &c., the period at which they are cut varies from six to ten years, according to the soil. When they are cut down for poles for hops and similar purposes, the periodical cuttings are commonly between twelve and fourteen years apart; and when they are cut down chiefly for the sake of the bark, they are seldom cut oftener than from fourteen to twenty-one years. A country abounding in coppice wood generally abounds also in singing birds, which are comparatively rare in countries where all the woods are of the pine and fir tribe.

Coprolite (Gr. *κόπρος, dung*; λίθος, *a stone*). The fossil excrement of animals. This name, given originally by Dr. Buckland to certain deposits which he discovered in the lias and determined to be the fæcal remains of the gigantic saurians of that period, has since become universally applied in consequence of the discovery of other large deposits of similar material in rocks of various ages. The true coprolites of the lias are like kidney potatoes, but of black or ash-grey colour, earthy texture, and glassy fracture. They are twisted, showing the mark of the intestine, and have been evidently voided of different degrees of hardness. They are generally accumulated in heaps in particular parts of the deposit.

Besides these coprolites of the lias, phosphatic nodules bearing the same name, but far more abundant, have been found below the chalk in various parts of England, and also in the crag beds of Suffolk. The former are in an earthy state, semi-indurated, and the latter stony.

The value of these minerals is derived from the phosphate of lime of which they are partly made up, and which is used with great advantage as mineral manure, after having undergone a cheap chemical treatment. In all parts of the country where either the crag or the upper greensand is found at the surface, search is now being made for this coprolite bed, and if found there is no want of candidates to purchase and utilise it. It is usually converted into a soluble superphosphate by the action of sulphuric acid; but in whatever form it is applied, it constitutes a valuable manure.

It is now many years since certain fancied flints in the crag of Suffolk were proved by Professor Henslow to contain animal matter, and their special value was soon proclaimed; but it was not till long afterwards that the yet more valuable accumulations were found in the greensands of Cambridgeshire and Sussex. The trade is now of great importance, and the production very large. The crag specimens yield, when washed and powdered, about 56 per cent. of phosphates, and are obtained from various places in Suffolk. The total yield in 1861 was estimated at about 10,000 tons. At present (1864) it is estimated at not more than from 2,000 to 3,000.

The greensand varieties are rougher externally, but yield as much as 60 per cent. of phosphates, and are more soluble than those from the crag. The principal localities are in Cambridgeshire and Hertfordshire. The annual yield is from 30,000 to 40,000 tons.

These coprolites contain from 4 to 5 per cent. of organic matter and a little silica; but from 70 to 80 per cent. of their whole substance is a mixed phosphate and carbonate of lime.

Coprophagans, Coprophaga (Gr. *κόπρος, dung*, and *φάγω, I eat*). A section of Lamellicorn beetles which live in and upon the dung of animals.

Copula (Lat. *a bond* or *tie*). In Logic, that part of the proposition which affirms or denies the predicate of the subject. The only true logical copula is the present tense of the verb *to be*, with or without the negative sign, 'is' or 'is not.'

Copy (Fr. copie). In the Fine Arts, a transcript from an original work of art. When an artist copies his own work, it is called a *duplicate* or *replica*.

Copy. In Printing, is the subject-matter to be printed, whether it be an original work in manuscript or a reprint: in the first case it is termed *manuscript copy*, or written copy; in the second, *printed copy*.

Copyhold. In Law, is a species of *customary estate*, said to be held by copy of court roll; i.e. where the tenant's title is evidenced by a copy of the rolls of a manor made by the steward of a lord's court. Customary estates are those which exist in real property subject to the custom of manors; and their peculiar characteristic is, that all alienations of them must be transacted, in part at least, in the lord's court, the ordinary mode of alienations being by surrender to the lord and admittance of the new tenant. The peculiar tenure called *copyhold* is derived from the tenure in *villain socage*, as it was termed, held formerly under a manor. This was in its origin a mere permissive tenure by serfs attached to the soil; and copyhold estates are still expressed in legal phraseology to be held 'at the will of the lord by the custom of the manor.' With respect to the incidents of dower, and other characteristics, they are frequently governed by the custom of the manor; but where this is not the case, they are under the same rules which govern the transmission and alienation of freehold property. By the Reform Act, copyholders for life, or a greater estate to the amount of 10*l*. per annum, are admitted to the exercise of the

electoral franchise in counties. The enfranchisements of copyholds has been promoted by various statutes, of which the latest is 21 & 22 Vict. c. 94 (1858). Its provisions are administered by the Copyhold Commissioners.

Copyright. In Law, the right of property in a literary composition vested in the author. By 54 Geo. III. c. 156, s. 4, the term of copyright in an author and his assignee extended to twenty-eight years absolutely, and for the life of the author if he survived that period. But by the 5 & 6 Vict. c. 45, the duration of all copyrights, whether the author be dead or alive, was extended to *forty-two* years; and it further provided, that if the author be alive at the expiration of this period of forty-two years from the publication of his works, he shall enjoy the copyright to his death, and that his heirs or assignees shall enjoy it for seven years after that event. A book of registry is kept at Stationers' Hall. The author or assignee of a pirated work has his remedy by action. The Act requires that five copies of every work should be delivered at the expense of authors and publishers, on demand in writing, for the use of a few favoured public and private libraries in the United Kingdom. In France, copyrights continue for twenty years after the death of the author. In most of the German states, they are perpetual; and a copyright secured in one state is good in all. Both in England and on the Continent, various other compositions, such as engravings, etchings, prints, photographs, maps, charts, sculpture of all kinds, and designs for articles of ornament and utility, receive from statute a protection analogous to that of literature.

Copyright, International. Has been introduced as yet only to a very limited extent between civilised nations. The German Diet framed a convention on the subject between its own members in 1837. The crown has power under 7 & 8 Vict. c. 12 (1845) to allow foreign authors privilege of copyright. In 1846, Great Britain entered into treaty with Prussia; 1847, with Hanover; 1851, with France; 1854, with Belgium.

Coquilla Nuts. The seeds of *Attalea funifera*, a South American palm. They are much used in turnery.

Coquimbite or **White Copperas.** A hydrated tersulphate of iron found in a felspathic rock, in the province of Coquimbo, in Chili. It appears to have been produced by the weathering of Iron Pyrites.

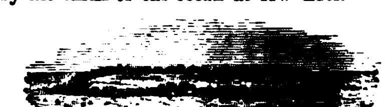
Coracite. An amorphous variety of Pitchblende, found in the syenite of the north coast of Lake Superior.

Coracle (Welsh, cwrwgl). A boat made of wicker-work covered with leather, still commonly used in Wales.

Coracoid (Gr. *κορακοειδής, like a crow*). A name first applied to a small process of the blade-bone of apes and man, on account of its resemblance to the beak of a crow; and now extended to a large flattened bone passing from the shoulder-joint to the sternum in birds, reptiles, and monotremes, and of which the process above mentioned is the rudimental representative.

Coral Islands (Gr. *κοράλλιον, coral*). In various parts of the ocean, but chiefly within the tropics, there are islands and groups of islands or long lines of reef rising to low-water mark, which are due entirely to the labour of the coral animal, and are among the most striking of the phenomena that connect organic with inorganic nature.

Coral reefs are usually of a form approaching to the circular, and the water is shallow in the centre, but surrounded by a very deep and even unfathomable sea. When the reef is so high as to remain nearly dry at low water, the animals leave off building; and then the rim or edge of the great basin becomes covered by calcareous sand, which offers a foundation for the growth of marine vegetables, and afterwards a resting-place for the seeds of trees and plants cast upon it by the waves. Trunks of trees also, carried by rivers from continents and islands, after their long wanderings are often pitched ashore; and sometimes carry with them small animals, such as lizards and insects, which become the first inhabitants of the new island. The Pacific Ocean, throughout a space comprehended between the thirteenth parallels of latitude on each side of the equator, is a great nursery of coral islands; as are also the Arabian and Persian gulfs. Between the coast of Malabar and that of Madagascar there is a great sea of coral. Flinders describes an unbroken reef 350 miles long upon the coast of New Holland, and between that country and New Guinea coral formations extend throughout a distance of 700 miles, interrupted by no intervals exceeding 30 miles in length. The growth of coral seems, when compared with human epochs, extremely slow; but the facts just cited show that they have produced results of no mean importance, as influencing the general aspect of the earth's crust. Their circular form, the steep angle at which they plunge into the sea, and the countries in which they occur, render it probable that they are the crests as it were, of submarine craters; and occasionally lava and volcanic rocks have been found in their central lagoons, which have generally a deep narrow passage, kept open by the efflux of the ocean at low tides. Such



Whitsunday Island in the Pacific, with its enclosed Lagoon.

openings are almost always on the leeward side, the windward side of the islands being more complete and perfect than the other. Owing to this fortunate circumstance, ships can enter and sail out with ease; indeed, the safety of many of these harbours is entirely

dependent upon this cause. It would seem to arise from the large masses of coral rock that are thrown up by the waves on the windward side. These rocks are probably subject to elevations and depressions connected with volcanic agencies. Perhaps the carbonate of lime, which is the building material employed by the busy little architects of these islands, is partly derived from calcareous springs issuing into the sea from fissures in the volcanic bottom. There is, however, an inexhaustible supply in sea-water itself. The following sections illustrate the peculiar mode of growth of coral:—

Section of a Coral Island.—*a a* the habitable part, *b b* the lagoon.

Section of a Coral Island upon a large Scale.—*a b* the habitable part; *b c* slope of the side; *c c* parts of the lagoon; *d d* knolls of coral.

Coral formations are among the oldest and the newest rocks that come under the notice of the geologist. The ancient limestones of the Silurian and Devonian periods, the vast masses of carboniferous limestone underlying the coal measures, the limestones of the coral rag, and many others of secondary age, with those at present in course of formation in many parts of the world, are all essentially the same. The species of coral are no doubt different, but the general resemblance of a group of the larger building species is wonderfully perfect. In most of the fossil reefs the limestone is much more compact than in those of recent date; and the interstices are partly occupied by drifted shells and fragments of smaller species. They are partly filled also by subsequent metamorphic action and the infiltration of carbonate of lime.

Coral Ore. A variety of Hepatic Cinnabar found at Idria in Carniola. It consists of curved lamellar concretions, with the form and apparent structure of fossil shells.

Coral Rag. A remarkable deposit consisting almost entirely of large corals resembling the kinds found in modern coral reefs. This bed occurs in the upper part of the middle division of the oolitic group in England. It is about forty feet thick, and large portions of it are frequently made up of one species of coral. It is also full of fragments of shells mixed with and occupying interstices between the corals. The typical coral rag is chiefly confined to Wiltshire, near Calne and Steeple Ashton; but it is imperfectly represented in Yorkshire.

Corallina. A name applied by Linnæus to a genus or group of marine organised bodies of arborescent habit, with jointed stems, supported on a kind of root, divided into branches, which are likewise jointed. Neither pores nor polypes are distinguishable on the surface of these beings; their chief purpose in the economy of nature is to prepare during life, and precipitate by their decay, fine particles of carbonate of lime or chalk: they thus lend their aid to the Lithophytous corals in covering submerged land with the elements of a fertile soil, which the expansive subterranean forces may afterwards convert into dry land.

Corallines. The name commonly applied to the tubular or nudibranchiate order of Polyps which have an external jointed calcareous or horny covering: the true nature of these plant-like animals was discovered by our countryman Ellis. [TUBULIFERA.]

Coran. [ALCORAN.]

Corbeils (Fr. corbeau). In Fortification, small gabions. [GABIONS.]

Corbel (Fr. corbeau). In Architecture, a projecting bracket often sculptured like a modillion, sometimes in the form of a basket, for the purpose of supporting a superincumbent object, or for receiving the springing of an arch. A corbel table is a projecting battlement, parapet, or cornice, resting upon a series of corbels.

Corculum (Lat. dim. of cor, *the heart*). An old name for what botanists now call the *embryo* of a plant.

Cordate (Lat. cordatus). In Botany, a term used in describing the general form of organs, to denote anything having two round lobes at its base, the whole resembling the heart in a pack of cards; as the leaf of *Alnus cordifolia.*

Cordeliers. The monks of the Franciscan order are so called, from the cord or girdle which they wear round the waist. They were originally called Friars Minor, or Minorites.

This name was also assumed by one of the Parisian political clubs, which numbered Danton and Marat among its chief members.

Cordiaceæ (Cordia, one of the genera). A natural order of arborescent Exogens, inhabiting the tropics of both hemispheres. They are nearly allied to *Convolvulaceæ*, from which they are separated by their inverted embryo and drupaceous fruit. They are sometimes associated with *Boraginaceæ*; but their plaited cotyledons and dichotomous style serve to distinguish them. The flesh of the fruit is succulent, as seen in the Sebesten plums, the produce of the *Cordia Myxa* and *C. Sebestena*; but otherwise they are of no value. It has been asserted that the wood from which the mummy cases of the Egyptians are made was that of *Cordia Myxa*; but there is no doubt that it was really produced by *Sycomorus Antiquorum*, formerly called *Ficus Sycomorus.*

Cordierite. A mineralogical synonym for Iolite.

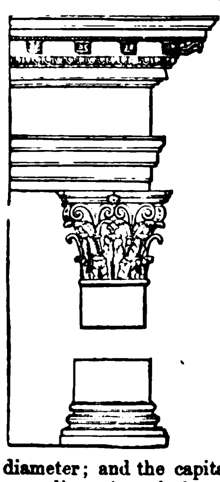
Cordon (Fr.). In Fortification, the coping of the escarp or inner wall of the ditch. It is usually rounded in front, and projects one foot over the masonry. A line of troops drawn round a town or tract of country, so as to prevent ingress or egress, is also called a *cordon*.

Coriander (Gr. κορίαννον). The seed of the *Coriandrum sativum*. This plant is a native of Europe, and is cultivated on account of its

**seeds, which are occasionally used in medicine; they have a peculiar perfumed flavour, with some bitterness, and form one of the ingredients of *curry powder*.

Coriariaceæ (Coriaria, the only genus). A natural order of shrubby Exogens, inhabiting Chili, Peru, the south of Europe, and a few other places. It is placed by De Candolle directly after *Ochnaceæ*, a member of the Rutal alliance, with which it agrees in some respects, but from which it differs essentially in being apocarpous. Some botanists consider them apetalous, and allied to *Phytolaccaceæ*; but the question of their affinity is still unsettled. Their sensible properties are of a poisonous nature.

Corinthian Order. In Architecture, one the five orders. The capital is a vase elegantly covered with an abacus, and surrounded by two tiers of leaves, one above the other; from amongst which stalks spring out, terminating at their summits in small volutes at the external angles of the abacus, and in the centre. The capitals of the Tuscan, Doric, and Ionic orders appear to be added to the tops of the columns; but the Corinthian capital seems to grow out of its shaft. The height of the column varies from $9\frac{1}{2}$ to $10\frac{1}{2}$ of the diameter; and the capital from $1\frac{1}{2}$ to 1 of the same dimension; the latter being their height in the celebrated example of the temple of Vesta at Tivoli. The entablature of this order is variously decorated. The architrave is usually profiled with three fasciæ of unequal height; though in some examples there are only two. The frieze is often sculptured with foliage, and the cornice decorated both with modillions and dentils: the former having a sort of baluster front with a leaf under them; and the latter, which are cut into the body of the band, being occasionally omitted, as are sometimes even the modillions. Among the principal remaining examples of the order at Rome, are the temple of Mars Ultor, the temple of Jupiter Stator, the portico of Severus, and the Pantheon; the temple of Vesta at Tivoli is a good example of the order slightly modified. The Tower of the Winds and the Choragic monument of Lysicrates at Athens are the only specimens of the Corinthian order, not being Roman work, to be found in Greece. [ARCHITECTURE.]



Corium (Lat.). In Anatomy, is the basis of the skin, or *true skin*, and consists of a vascular and fibro-cellular tissue, of interlaced dense, but elastic, filaments. It rests on the subcutaneous cellular tissue, and is covered by the cuticle or *scurf skin*.

Cork (Ger. kork, Span. corcho). The bark of the *Quercus Suber*, a species of oak growing in the southern provinces of Spain, France, and Italy. When rasped cork is digested in water and alcohol, it leaves from 70 to 80 per cent. of insoluble matter, which has been called *suberine*, and which by the continued action of nitric acid is converted into *suberic acid*.

Corm (Gr. *κόρμος, a trunk* or *stem*). In Botany, a short roundish bulb-like underground stem, solid and not scaly; as in the Crocus and Gladiolus.

Corn. The seeds of certain grasses which have been immemorially used as food, for man or animals, are called *corn*; and those which are used exclusively or principally by man are called *bread corn*. The term is also sometimes applied to the seeds of other plants which may be ground into meal and used as food, such as the seeds of the buckwheat, the quinoa, and of certain leguminous plants, which, however, are more properly denominated *pulse*. The principal bread corns of temperate climates are wheat, rye, oats, and barley; those of warm climates are maize, rice, and millet; and those of cold climates, oats and barley.

Value of the Produce of Corn.—In agricultural countries, not in a very high state of civilisation, the culture of corn is the principal employment of the great bulk of the community; and in all considerable countries, how far soever they may be advanced in arts and refinement, its culture is always by far the most extensive as well as the most important branch of national industry. No great country, perhaps, ever existed, the population of which was so extensively engaged in manufactures and commerce as that of Great Britain. Still, however, we employ about a quarter of our inhabitants in agriculture; and of these, fully three-fourths are directly or indirectly engaged in the raising of corn. Unfortunately, there are no accounts, on which it would be safe wholly to rely, of the ordinary produce of corn, either in this or any other great country. But, without pretending to peculiar accuracy, we are inclined to think that the present (1865) average growth of all sorts of corn in the United Kingdom may be safely estimated at about 70,000,000 quarters, of which about 62,000,000 may be consumed by man and the lower animals. Now supposing this estimate to be nearly accurate, and taking the average price of the different descriptions of corn at 30*s.* a quarter, the total value of the corn annually produced will amount to the sum of 100,000,000*l.* sterling: quite sufficient to evince the paramount importance of agriculture as a source of wealth as well as a means of subsistence.

Corn Laws.—This superior importance of corn as an article of culture, and the dependence so generally placed upon it as an article of food, are the causes why the trade in it has been so very generally subjected to regulation. It is long even before the most enlightened portion

of an instructed community become satisfied of the advantage of permitting the supply of corn or any indispensable article to be adjusted, like that of less important things, by the unfettered competition of private individuals. It seems, at first sight, reasonable to suppose that the most likely way to secure plenty at home is to impose restrictions on exportation; but in truth and reality, this is very far from being the case. However fertile it may be, no country that imposes restrictions on exportation need hope to escape perpetually recurring scarcities; for wherever free exportation is prevented, the excess of supply that occurs in plentiful years, being thrown wholly upon the home market, depresses prices to such an extent as to be ruinous to the farmer; and thus, by injuring agriculture and lessening the quantity of the land in corn, never fails to occasion a scarcity on the occurrence of a deficient harvest. In Great Britain, however, the policy has long been to give every facility to exportation, and even to lay restrictions on importation. This has arisen from our legislature being principally composed of individuals dependent on and connected with the land; and whose interest consequently has led them to endeavour to secure as high a price as possible for its produce. But it is needless to add that this policy is, if possible, even more objectionable than the other. Instead of being publicly advantageous, high prices are, in every instance, distinctly and completely the reverse. The less the sacrifice of money or of labour for which corn or any other article can be procured, so much the better. But to make sure that the price of corn, or of anything else, will be fixed at the lowest limit at which the required supply can be obtained, all that is necessary is to abolish all restrictions, whether on exportation or importation. Freedom is the parent of abundance, cheapness, and equality of price; restriction, of scarcity, dearness, and uncertainty. Any interference with the trade in corn, or with any other great department of trade, that has not the removal of natural or artificial restraints for its object, is not only inconsistent with the best established principles, but is sure to be pernicious. In this, as in all other things connected with national industry, the short and only safe rule is to leave individuals to pursue their own interest in their own way.

Our limits forbid our attempting to make any enumeration of the various statutes that have been passed at different periods for regulating the trade in corn. Down to the Revolution, the policy was to restrict exportation; but from that period the contrary policy has been pursued, and the legislature has pretty uniformly endeavoured to facilitate exportation, and to prohibit or fetter importation. It was not, however, till about 1770 that the restrictions on importation began to have much practical influence. But about that time, population having begun rapidly to advance in consequence of the extraordinary impulse given to manufacturing industry by the inventions and discoveries of Watt, Arkwright, Wedgwood, and others, the price of corn in England began to rise above its price on the Continent; and from being an exporting we became an occasionally, or rather a pretty constantly, importing country. Had there been no restrictions on importation, our prices, it is plain, could not have exceeded those of the adjoining Continental states by a greater sum than might have been required to defray the cost of importing into this country. The restrictions, however, overturned this natural principle; and in deficient years added materially to the difference between our prices and those of the Continent.

At the close of the war, in 1814 and 1815, the renewed intercourse with the Continent led to a great importation of corn, which occasioned a sudden and heavy fall of prices, productive of much severe distress amongst the farmers. Parliament endeavoured to obviate this by increasing the restrictions on importation; a device which had, in part, the anticipated effect. But since 1820, the influence of improved communications and of ameliorations in agriculture has been so very great, that, notwithstanding the vast increase of population, prices have been progressively falling, and were, in 1835, lower than in any previous year since 1787. Practically, therefore, the influence of the restrictions was materially diminished, and a much greater effect was usually ascribed to them in ordinary years than they really exerted. No doubt, however, they tended materially to aggravate the scarcity and suffering originating in a deficient harvest, and were, therefore, very mischievous to the public; and as inducing great fluctuations in price at all times, they were a serious inconvenience to the farmer.

But despite these defects the corn laws might have maintained their place on the statute-book indefinitely. It is true that they were assailed by the highest authorities on political economy, and were attacked by the formidable organisation of the leaders in the free-trade movement. But, like many other protective schemes, they *seemed* to offer a security, or at least an advantage, to a particular class of persons, and were therefore clung to with great tenacity. But the unsatisfactory corn harvest of 1845 and the failure of the potato crop of that year made it necessary to adopt extraordinary measures for making good the deficiency in the supply of food. Under the circumstances the suspension of the corn laws could hardly have been avoided. But if once suspended, their re-enactment would have been all but impossible; and it was better, by at once providing for their repeal, to make an end of the system, and of the dissatisfaction and agitation to which it had given birth, than to endeavour to continue it in any modified shape. Such was the view of the matter taken by Sir Robert Peel, and he fortunately succeeded, notwithstanding the most formidable opposition, in carrying the Act 9 and 10 Vict. c. 22, which provided for the immediate

modification of the corn laws, and for their final abolition on February 1, 1849. From that period all varieties of corn, with meal, flour, &c., have been admitted to consumption under the all but nominal duties, the former of 1*s.* a quarter, and the latter of 4½*d.* a cwt.

Rate of Production in England, and Amount of Imports.—There is no doubt that the agricultural produce of this country has increased largely in quantity during the present century, and still more largely when its amount is contrasted with that derived from the soil by ancient systems of agriculture, and in the middle ages. We know that Sicily was considered the granary of ancient Rome, and yet Cicero tells us that the amount of produce was, in very favourable years, ten times the seed sown, and in a fair average year eight. It could be proved incontestably by existing documents, that the same, or even a less rate, characterised the agriculture of this country in the thirteenth and fourteenth centuries, and that, consequently, imports being insignificant or uncertain, the population maintained on the soil could not have exceeded two millions, and probably did not equal one million and a half.

Agricultural science has not only made it possible that the actual return to the seed should reach sixteen, twenty, and, in some cases, thirty and thirty-five times, but by the discovery of certain processes has, even under the supposed discouragement of corn cultivation by the cheapness of imported grain, certainly enlarged, and perhaps doubled, the area devoted to cultivation. The ancient system of agriculture, to which deep ploughing, efficient draining, and artificial manures were unknown, necessitated, in order to reinvigorate the soil, frequent fallows. Our forefathers were unacquainted with root crops; the turnip, the swede, the carrot, and the mangold being of comparatively recent introduction. One of the purposes which these roots fulfil is the fertilisation of the soil for grain crops; another is the possibility of keeping large stocks of sheep and cattle, and of at once supplying the market with meat, of diminishing the time at which stock is ready for sale to one-third of that which was required of old, and of furnishing an enormous increase of natural manures. Concurrently with these improvements in agriculture, the breeding of stock has, in consequence of the care devoted to selection, become almost an exact science, and the clumsy and unprofitable sheep, pigs, and cattle of our forefathers have been replaced by herds carefully chosen for their symmetry and fitness, the breeder giving all his attention to the purpose of producing the greatest possible result at the least possible cost. Again, our forefathers were constrained to be content with natural grasses only, whereas modern science has been able to appropriate, by means of careful observation and judicious experiment, a multitude of foreign or artificial grasses, the produce of which is more certain and more abundant. Lastly, mechanical appliances have been largely employed in agriculture. Hand-sowing has been generally superseded by drilling, the steam-engine has taken the place of the flail, the reaping and mowing machine are rapidly being employed for harvest labour, and it is likely that before long the steam plough will be generally adopted. In short, the cultivation of corn, instead of being carried on as of old by rude implements and imperfect experience, is now either directly or indirectly connected with and dependent on mechanical science, chemistry and even physiology; and consequently an enormous increase of absolute production is achieved at a diminishing cost.

It is not possible to determine with any precision the amount of the grain produce of this country. With an obstinacy seriously disadvantageous to their ultimate, and probably to their immediate interests, the landowners and tenant farmers in England have resisted the proposal to collect agricultural statistics, on the plea that such enquiries would be inquisitorial and vexatious. But if so, the inquisition and vexation is inflicted and endured with patience, and even thankfulness, by other trades. Merchants and manufacturers are glad to know the amount of foreign produce at present in the market, or available for sale; and they are possessed of all such information to the full. Nay, the quantity of those commodities which seem to compete most notably with the possible profits of the British farmer, corn and wool, with what is annually imported and what is held for consumption, are known to the quarter and the pound, while the amount of British produce can only be guessed at. It is almost needless to say, that when buyers are ignorant or ill-informed of the quantity of the commodity available for sale, the greatest inconveniences are experienced from fluctuations in market prices.

The imports of grain have latterly been extremely large, indicating that, considerable as has been the improvement in agriculture, the gross amount is insufficient for the demands of the population. The annual import of wheat and flour of wheat, reckoned together, which amounted in 1845 to 315,615 quarters, and in 1846 to 2,962,928 quarters, varied between 3 and 6 millions of quarters per annum between 1847 and 1859. In 1860 it exceeded 7,000,000, in 1861 it exceeded 8,000,000, and in 1862 it amounted to 11,528,445 quarters—more than ten-fold what it was in 1845. And the annual importation of other kinds of grain and meal has also increased during the same period. Varying in general from 4 to 5 millions of quarters between 1846 and 1859, it exceeded 7,000,000 in 1860-61-62.

Although, however, we are not able to determine with any degree of precision the amount of cereal *produce* in Great Britain, the figures supplied by the comptroller of the corn returns as to the amount of wheat and flour imported into the United Kingdom enable us to determine with some accuracy the annual *deficiency*.

In the three years 1860–1–2, the amount far exceeded the quantity imported in any previous

year. These harvests were known to have been very scanty, and by far the largest portion of the foreign supply reached this country from the western portion of the United States. Indeed, the dependence of this country on the regular transmission of grain from these regions is nearly as complete as that of the cotton districts was on the growth of the raw material in the southern part of the same regions, and of far greater significance both from an economical and political point of view.

There do not appear to be any reasonable grounds for the alarm entertained by some economists, as to the cessation or straitening of supplies of grain from foreign countries. The corn-producing regions of Western America are almost boundless, and the facilities of transit keep pace with the occupation of the soil. The country is traversed by vast navigable rivers, and the people rapidly construct railways and canals for the purpose of traffic. The town of Chicago, the entrepôt of the corn trade, increased its population from 30,000 in 1850 to more than 100,000 in 1860, and is still progressing at the same rate. A rise of a few shillings in the market price of wheat in England makes it advantageous to export the produce of many farms, which cannot yet, in consequence of the cost of carriage, secure a profit at a lower price. And while the soil is boundless, its fertility is astonishing. It is a common thing for the same field to be cropped with Indian corn for twenty years successively, and this without the application of a particle of manure, and without apparently any diminution in the amount produced. Cargoes of wheat of the finest quality have even been imported from California by the Cape Horn passage.

The great increase of consumption in the article of foreign corn does not necessarily indicate that the general produce of the United Kingdom has fallen. It only proves that by reason of abundant foreign supply the people are better fed. Nor is this the only advantage. A well-fed people has always more means in its power for the consumption of other commodities; for it is clear that the demand for commodities other than necessaries of life will always be in proportion to the margin left over after these exigences are satisfied. Plenty of food, then, if it does suggest that the profits of the agriculturist are diminished in one quarter, is equally demonstrative of the fact that his profits are enlarged in another, and that the general consumption of the people is proportionately increased. This inference, which may be established on purely abstract grounds, is verified in fact by the increased value of real property, and the notoriously general rise in rents.

It may be observed that wheaten bread has been the customary food of the English people from the earliest times. This kind of grain is, as far as quantity goes, the least productive of all cereals, needs soil of good quality for its growth, and requires careful preparation in order that the produce may be remunerative. Hence a scarcity of wheat makes a resource to other kinds of grain possible, and interposes a considerable distance between want and famine. Far different was the case with the Irish before the failure of their staple crop. In that country the peculiar occupancy of land, among many other causes, led to absolute dependence on the potato for subsistence. When this crop failed, the people could get no other food, because they had subsisted on the cheapest kind procurable. Hence the extreme distress of the Irish famine.

Information as to the average annual price of wheat in England has been supplied by official authority since the year 1583. At this period, the result of the great additions to the currency, consequent upon the discovery of large and very productive mines of silver in South America, was beginning to be generally felt, and was producing serious effects on fixed rents and payments. The purpose of the statute was to determine a portion of these rents into wheat and malt, and returns of the highest price at which these commodities were sold on particular days in the year were ordered to be registered in the principal market towns. For those of an earlier date than that at which the subjoined table commences, the reader is referred to Lloyd's *History of Corn Prices*. Trustworthy information on the period preceeding 1583 is, however, still a desideratum in economical history.

Account showing the Quantities of Foreign and Colonial Corn, Flour, &c. entered for Consumption in the United Kingdom in each of the Thirty-four Years ending with 1863. (Compiled from *Parliamentary Papers.*)

Years	Wheat and Flour	Barley	Oats and Oatmeal	Rye
	Qrs.	Qrs.	Qrs.	Qrs.
1830	1,727,847	48,505	904,472	19,189
1831	1,506,740	514,610	355,492	56,208
1832	376,755	77,988	3,082	60
1833	84,036	1,226	975	1
1834	64,974	11,071	55,620	22
1835	28,554	136,858	176,142	3
1836	30,107	110,021	97,197	18
1837	244,272	47,475	334,024	19,576
1838	1,848,475	8,192	11,072	2,517
1839	2,711,723	594,301	862,789	152,182
1840	2,401,436	619,801	517,052	1,857
1841	2,647,808	222,837	27,918	518
1842	2,989,645	49,969	295,487	28,516
1843	990,523	223,543	45,254	2,724
1844	988,515	1,020,766	258,235	28,779
1845	315,615	299,430	587,484	23
1846	2,962,928	404,644	779,442	1,710
1847	4,612,110	782,686	1,788,057	253,510
1848	3,082,230	1,054,275	967,054	62,635
1849	4,802,475	1,381,000	1,267,106	240,556
1850	4,830,263	1,043,051	1,165,850	94,078
1851	5,330,412	829,564	1,198,529	24,609
1852	4,164,603	625,540	989,287	9,967
1853	6,235,860	828,670	1,035,072	76,700
1854	4,473,083	552,972	1,014,949	5,916
1855	3,211,760	349,110	1,033,727	2,358
1856	5,207,147	731,412	1,146,848	27,981
1857	4,060,283	1,701,473	1,710,299	76,048
1858	5,343,469	1,661,392	1,856,281	103,520
1859	4,951,871	1,727,853	1,677,585	81,152
1860	7,334,164	2,112,861	2,290,951	96,841
1861	8,670,797	1,400,401	1,859,781	54,142
1862	11,528,445	1,854,944	1,609,816	1,964
1863	7,315,494	2,067,932	2,362,031	22,413

Account of the Average Prices of British Wheat per Quarter, in England and Wales, since 1771, *as ascertained by the Receiver of Corn Returns.*

Years	Wheat			Years	Wheat			Years	Wheat		
	£	s.	d.		£	s.	d.		£	s.	d.
1771	2	7	2	1802	3	7	5	1833	2	12	11
1772	2	10	8	1803	2	16	6	1834	2	6	2
1773	2	11	0	1804	3	0	1	1835	1	19	4
1774	2	12	8	1805	4	7	10	1836	2	8	6
1775	2	8	4	1806	3	19	0	1837	2	15	10
1776	1	18	2	1807	3	13	3	1838	3	4	7
1777	2	5	6	1808	3	19	0	1839	3	10	8
1778	2	2	0	1809	4	15	7	1840	3	6	4
1779	1	13	8	1810	5	6	2	1841	3	4	4
1780	1	15	8	1811	4	14	6	1842	2	17	3
1781	2	4	8	1812	6	5	5	1843	2	10	1
1782	2	7	10	1813	5	8	9	1844	2	11	3
1783	2	12	8	1814	3	14	0	1845	2	10	10
1784	2	8	10	1815	3	4	4	1846	2	14	8
1785	2	11	10	1816	3	15	10	1847	3	9	9
1786	1	18	10	1817	4	14	9	1848	2	10	6
1787	2	1	2	1818	4	4	1	1849	2	4	3
1788	2	5	0	1819	3	13	0	1850	2	0	3
1789	2	11	2	1820	3	7	11	1851	1	18	7
1790	2	13	2	1821	2	16	2	1852	2	1	0
1791	2	7	2	1822	2	4	7	1853	2	13	0
1792	2	2	11	1823	2	13	5	1854	3	12	7
1793	2	8	11	1824	3	4	0	1855	3	14	9
1794	2	11	8	1825	3	8	7	1856	3	9	2
1795	3	14	2	1826	2	18	9	1857	2	16	5
1796	3	17	1	1827	2	16	9	1858	2	4	4
1797	2	13	1	1828	3	0	5	1859	2	3	9
1798	2	10	3	1829	3	6	3	1860	2	13	1
1799	3	7	6	1830	3	4	3	1861	2	15	6
1800	5	13	7	1831	3	6	4	1862	2	15	5
1801	5	18	3	1832	2	18	8	1863	2	4	9

Cornaceæ (Cornus, one of the genera). A small natural order of epigynous Exogens, of the Umbellal alliance, formerly associated with *Caprifoliaceæ*, but now separated on account of their polypetalous structure. They are known by their two (or more) celled fruit without a double epigynous disc, their tetramerous flowers, valvate corolla, and opposite leaves without stipules. Some North American species of *Cornus* are valuable as tonics.

Cornbrash. A member of the lower part of the great oolitic series of England, made up of rotten impure limestone decomposing into a good wheat soil. [Brash.]

Cornea (Lat. *horny*). The transparent membrane of a horny texture which forms the anterior part of the eyeball. In vertebrates it is simple: in insects it is subdivided into numerous hexagonal segments.

Cornet (Ital. cornetta, *a small flag*). A commissioned officer in the cavalry, corresponding in rank with the ensign of infantry. The standard used to be carried by the cornet—hence the name of the latter—but is now carried by a troop sergeant-major.

Cornet. In Music, a shrill wind instrument formed of wood, which appears to have been in use in the earliest times, and remained so till about the commencement of the eighteenth century, when it was displaced by the oboe.

Cornet-à-Pistons (Fr.). A brass wind musical instrument, of the French horn species, but capable of much greater completeness of scale and perfection of intonation from the valves and stoppers (pistons) with which it is furnished, and whence it derives its name. The tribe of instruments to which this belongs has of late years been much improved, principally by Messrs. Sax of Paris, and Messrs. Distin of London. There are now four or five grades of instruments of this class, which take different parts respectively, forming, in the whole, a perfect band of themselves, and capable of playing almost any kind of music. The cornet-à-pistons is the treble instrument, and there are others for the alto, tenor, baritone, and bass parts, gradually increasing in size, but all on the same general construction. They are much used for military bands, and for music played in the open air.

Cornice (Fr. corniche; Ital. cornice). In Architecture, the upper great division of an entablature [Entablature], consisting of several members.

Cornin. A bitter crystalline matter obtained from the bark of the *Cornus florida*.

Cornish Diamonds. Transparent colourless Rock Crystals found in Cornwall.

Corns. Thickenings of the cuticle of the toes, of a horny texture, arising from continued pressure over a projection of bone. One of the best and simplest remedies for this painful disorder is to wear upon the toe or part affected a piece of leather, spread with diachylon or other emollient plaster, and having a hole in it corresponding with the size of the corn. By this means all pressure upon the corn is avoided. (Sir B. Brodie's *Lecture on Corns and Bunions, Medical Gazette*, Feb. 13, 1836.)

Cornstone. The lower member of the old red sandstone, or middle Palæozoic series of rocks, as developed in Herefordshire and the adjoining counties. The name was given from the fertility of the soil derived from the rock, which there consists of a mixture of sandstones and impure concretionary limestones, readily decomposing into a good material for all the corn crops. These cornstones repose on imperfect flags, some of which are extensively quarried.

Cornu Ammonis (Lat.). A name sometimes applied to the fossil shells called Ammonites.

Cornua (Lat.) or **Horns.** In Zoology, hard and more or less elongated processes projecting from the head. The term is usually applied to such processes in the class Mammalia, in which they serve as weapons of offence and defence. These weapons consist either of bone, when they are called *antlers*; or of horn, or of bone and horn, or lastly of bone and hairy skin. The first kind of horns are peculiar to the deer tribe; the second to the rhinoceros; the third to the sheep, ox, and antelope tribes; and the fourth to the giraffe. The bony horns, antlers, cerata, or *cornua solida*, as they are technically termed, during the whole period of their formation resemble the horns of the giraffe, inasmuch as they are covered with a hairy and highly vascular integument: the bony material of these processes is in fact secreted by the vessels of that integument, so that their coexist-

ence is essential as long as growth proceeds. When their growth is completed, and the antlers have arrived at their characteristic size and figure (which in the elk and Wapiti deer are truly remarkable), the determination of blood to the parts gradually lessens; the vessels shrink; the circulation in the formative membrane is at length suppressed; and the tegument then shrivels, dries, cracks, and is rubbed off by the instinctive actions which the deer now almost ceaselessly performs with his newly acquired and consolidated antlers. The skin and periosteum of the head, once continuous with those of the antler, now terminate at an abrupt line at the base of the antler, from which a ridge of bone, or *burr*, as it is termed, is developed, apparently for the purpose of defending the margin of the persistent integument; for when this is continued, as in the Munt-jac deer, half-way up the antlers, the burr is developed immediately above its termination, or at the middle, and not at the base of the antlers. Some physiologists have conjectured that the use of the *burr* was to compress the vessels of the periosteum of the antler, and that its formation was deferred to near the completion of the antler; but observation shows that it commences at an earlier period of growth; and sound physiology teaches that the cessation, like the commencement, of the growth of the horn, must be the result of deeper and more constitutional operations. The most remarkable fact in the economy of antlers is that they are shed and renewed annually, the fall of the horns being concomitant with the shedding of the hair. The attempts to assign the final cause of this phenomenon have not been very successful. In the axis deer, e.g., the bucks do not all shed their horns at the same time, but at different periods of the year. In the reindeer the branches which project forwards from the base of the horn, or the brow antlers, are habitually used to scrape away the snow which conceals the lichens on which they principally feed. The female, therefore, needs antlers as much as the male, and she has them; but this is a rare and singular exception, for the females of other species of deer are destitute of these ornamental weapons. True horns, or those which consist either partly or entirely of horny material, are never shed. In the antelopes they are in almost all cases confined to the male, and their bony basis is generally solid; in sheep and oxen the horns are commonly present in both sexes, and the bony basis is hollow. The term *cornua cava* is, however, usually applied to all horns consisting of bone and horn, and reciprocally the ruminants having such horns are termed *hollow-horned*. But this extension of the term seems to have arisen from a consideration of the external horny sheath alone, which is but a part, and that not the most essential, of the horn. The horn or horns of the rhinoceros consist of an agglutination of horny fibres, which are attached only to the integument; the integument adhering with more than usual firmness at this part to the roughened surface of the bone beneath. The horn of the rhinoceros differs from that of other mammalia in being situated upon the median line of the forehead; so that when there are two, they are placed one behind the other, and not laterally and symmetrically, as in the ruminants.

A few ruminants have naturally two pairs of horns; and this was the case with a great extinct species, *Sivatherium*, whose remains have been discovered in the Himalayan mountainous regions, where the small *Antilope quadricornis* still exists. Horns are characterised in zoological descriptions according to their position, as *Cornua nasalia*, *frontalia*, *parietalia*, &c.: or according to their direction, as *Cornua prona*, turned forwards; *reclinata*, turned back; *incurva*, bent inwards; *vara*, bent outwards; *redunca*, with the apices curved forwards; *lyrata*, when they represent the horns of the ancient lyre; *gyrata*, when spirally twisted: or according to their period of existence, as *Cornua perennia*, when they last the lifetime of the animal; or *Cornua decidua*, or *annua*, when annually shed: lastly, horns are termed *Cornua ossea*, *Cornua solida*, *cava*, according to their structure, as above described. For the peculiarities of the giraffe's horns, see GIRAFFE.

Certain species of many other classes have parts projecting from the head, analogous in form or structure to the cornua of the mammalia. The frontal protuberance of the emeu, hornbill, and helmeted curassow consists of bone covered with a sheath of horn; the kamichi or horned screamer is a still more remarkable example of a bird so armed. In reptiles we find horned toads, vipers, and iguanas. Fishes present divers simulations of true horns. In mollusca retractile feelers or eye-stalks are commonly called *horns*, as in the snail; but the appendages which would come under the general definition of our present term arrive at their maximum relative size, variety, and singularity of form in the class of insects.

Cornucopia (Lat. cornucopiæ, *horn of plenty*). In the Fine Arts, an ornament representing a horn, from which issue flowers, fruits, leaves, and the like. The fable accounting for the origin of this emblem of Plenty, is that Amalthæa, when one of her goats had broken off a horn against a tree, presented it to the infant Zeus (Jupiter) wreathed with flowers and filled with fruit. The cornucopia is found very frequently in the types of ancient coins, particularly upon those of Sicily. (See the medal of Arsinoe.)

Cornwallite. An amorphous arsenate of copper found in Cornwall.

Corolla (Lat. *a garland*). That envelope of a flower which is placed next within the calyx. It is usually more richly coloured and larger than the latter, but is extremely variable in this respect. Owing to its being in many plants one of the most striking parts of the flower, it is much employed by botanists in their systematical arrangements, and by the French school

has been taken as the means of forming fundamental characters of the subclasses in the great Dicotyledonous division; but there is no doubt that its importance for this purpose has been much overrated. Theoretically considered, the corolla is composed of modified leaves, with the ordinary organisation of which its parts or petals correspond as much as can be expected of rudimentary organs. Its physiological action is to absorb oxygen, without decomposing carbonic acid, in which respect it agrees with leaves in their morbid state in the autumn.

Corollary (Lat. corolla, dim. of corona, *a crown*). In Mathematics, denotes any consequence immediately deducible from the demonstration of a proposition. All the corollaries in our editions of Euclid have been inserted by editors; they constitute, in fact, so many new propositions differing from the original ones merely in the *fact* that the demonstrations have been omitted. Had Euclid thought fit to make a greater demand on the intelligence of his readers, many of his propositions might assuredly have been given as corollaries.

Corona (Lat.). In Architecture, the flat, square, massy member of a cornice, very frequently called the drift or larmier; its situation is between the cymatium above and the bed-moulding below, and its use is to carry the water, drop by drop, from the building.

CORONA. An appearance seen round the sun in total eclipses of that body. [SUN.]

Corona or **Coronet.** This word is employed by botanists to express certain appendages of the corolla, which are arranged within it in a circle. In the *Narcissus* it is a cup; in *Symphytum* it consists of five glandular narrow processes; in *Asclepias* it is a thick fleshy ring extended into bended lobes. In all cases the coronet is a modification of sterile stamens.

Corona Australis and **Corona Borealis** (Lat. the *southern crown* and *northern crown*). Two of the old constellations of Ptolemy; the first in the southern and the second in the northern hemisphere.

Corona Dentis (Lat.). In Zoology, the exposed part of a tooth, which projects beyond the alveolus and gum.

Coronamen (Lat.). In Zoology, the superior margin of a hoof, called in veterinary surgery the *coronet*.

Coronary (Lat. coronarius, *relating to a crown*). Coronary vessels and ligaments are those which spread round certain viscera, bones, &c.

Coronation. [KING.]

Coroner (Lat. coronator). Is the title of an office established before the Norman Conquest, of which the holder was, as his name indicates, in a peculiar manner the officer of the crown, whose private rights of property, whether arising by escheat, wardship, or consisting in demesne, it was his business to maintain and superintend in the county for which he acted. Connected in some degree with this character is the more important if not the sole function which he now exercises: that of holding inquests on the bodies of such as either die or are supposed to die a violent death (4 Edw. I. st. 2); for which purpose he is empowered to summon jurymen out of the neighbourhood, and witnesses. Should violent death be occasioned by any personal chattel, it was forfeitable as a deodand to the crown until the abolition of deodands by 9 and 10 Vict. c. 62. The coroner was originally in some sort the colleague and assistant of the sheriff, and in his default might still act as sheriff in the execution of writs, which in such case would be directed to him. The county coroner is still, as the sheriff was formerly, elected by the freeholders of the county. Generally there are four or six for each county; and coroners may now also be appointed for districts in their counties. Borough coroners are also appointed in towns having quarter sessions. Coroners are remunerated by fees under Acts of Parliament.

Coronet (Lat. corona). In Heraldry, an inferior crown belonging to the British nobility. The figure of John of Eltham, second son of Edward II., who died in 1334, affords the earliest representation of this ornament. Barons do not appear to have borne them earlier than the reign of Charles II. The time at which the coronets of the present orders of nobility were respectively distinguished in the existing fashion cannot be ascertained.

Coronet-bone. The second of the consolidated phalanges of the horse's foot.

Corporal (Ital. caporale, from capo, *the head*). A non-commissioned officer in the army, next in rank to a sergeant. He is distinguished by two chevrons or stripes worn on the arm.

Corporal Punishment. In the Army, is inflicted on the bare back with a cat-o'-nine-tails. It is limited in amount to fifty lashes, and, by a rule lately made, every soldier is exempt from liability to it until by gross misconduct he forfeits that exemption; and even after thus forfeiting his right to exemption he is liable to corporal punishment only for grave offences, while one year's good conduct restores him to his original position.

Corporation (Lat. corpus, *body*). A body politic or incorporate; consisting of a person or persons having power to take and grant, &c., to himself or themselves and their successors. Corporations, in English Law, are divided—1. Into sole and aggregate. Sole corporations are such as consist of a single person who is constituted a corporation by law, for the purpose of enjoying certain advantages and incurring certain duties, transmissible to his successors. Such is the parson of a living in respect of his benefice; a bishop, in respect of the ecclesiastical rights and property of his see; the king, &c. Corporations aggregate are such as consist of more individuals than one, and are kept up by a perpetual succession of members. 2. Into ecclesiastical and lay. Parsons, bishops, deans, and chapters are instances of the former. The latter are

again subdivided into civil and eleemosynary. Among the first are trading companies and municipal corporations; among the latter, hospitals, colleges in the universities, and similar establishments (which, however, were anciently esteemed ecclesiastical).

By the law of England, corporations are erected only with the king's consent, express or implied; and may exist by prescription, by letters patent, or by Act of Parliament. Bishops, parsons, &c., may indeed be said to exist as corporations by force of the common law; but some ancient municipal bodies, such as the corporation of London, are in a stricter sense corporations by prescription. Corporations by Act of Parliament may be created either expressly or by implication; as, where a body is to take lands by succession, this constitutes them a corporation. But the ordinary mode by which they are erected is by the king's letters patent or charter of incorporation; persons exercising the power of founding corporations by a grant of their own (as the chancellor of the university of Oxford) being for this purpose only delegates of the king.

The chief incident of a corporation is the power of taking by succession. This power is, however, confined in the case of sole corporations to estates of freehold; corporations aggregate only can take goods and chattels by succession. Grants by a corporation aggregate must be by deed under their common seal, which is necessary to give validity to most of their acts. A corporation has essentially the power of making by-laws to bind its own members, which are valid so far as they are not contrary to the laws of the kingdom. Corporations ecclesiastical and eleemosynary may, moreover, be subject to rules or statutes imposed by the king or the founder; civil corporations only to the common law and their own by-laws. In aggregate corporations, the act of the majority is the act of the whole.

The common law capacity of corporations to take lands has been, however, materially narrowed by statute. Thus a devise of lands to a corporation by will is bad, except for charitable purposes. And, in consequence of the Statutes of Mortmain [MORTMAIN], a corporation, whether lay or ecclesiastical, must now have a licence from the king in order to purchase.

All corporations are said to be subject to visitation. The visitor of ecclesiastical corporations is the ordinary [ORDINARY]; the visitor of lay corporations is the founder. In eleemosynary corporations this right, therefore, is in the founder and his heirs, or in such person as he has appointed: in civil corporations, the king is visitor, and exercises that jurisdiction in the King's Bench; where alone misbehaviour of such corporations or their officers can be enquired into, chiefly by means of the processes termed MANDAMUS and QUO WARRANTO [which see]. A corporation is dissoluble—1. By Act of Parliament; 2. In the case of an aggregate corporation, by the death of all its members; 3. By surrender of its franchises into the hand of the king; 4. By forfeiture of its charter through negligence or abuse of the franchise.

Corporations, Municipal. These bodies, which have acted so important a part in the history of modern Europe, originated in the Italian and provincial towns subject to the Roman sway.

In England we have no record of the internal constitution of our towns prior to the Anglo-Saxon settlement, and during those times our information is extremely scanty and imperfect. The magistracy in English towns appears to have been elective; that in Danish, hereditary. In Domesday Book we find in every town (eighty-two in all, in those parts of the record which remain to us) a certain number of persons mentioned as *burgesses*; a number sometimes equalling, sometimes falling far short of the houses enumerated. Boroughs at this period were exempt from the immediate jurisdiction of the sheriffs of the counties in which they were situate: they possessed their own hundred courts, leets, and view of frankpledge; but they were liable for various duties to the king, who was usually lord of the leet, i.e. exercised jurisdiction in the borough; and to the lord of the soil also, if there were any. It became usual after the Conquest for the king to let the fees and revenues thus due, together with the right of appointing the officers of justice, to the burgesses in general; and by this species of enfranchisement the borough became an independent municipality. But a free borough was constituted by having, in addition to those powers, exemption from the king's tolls, granted to its burgesses by royal charter. Such continued to be, in substance, the condition of English boroughs for several centuries.

During all this period no one seems to have doubted the capability inherent in the burgesses of a town, as a community, to take and enjoy lands, tolls, or other hereditaments, to themselves and their successors. But about the period of the reigns of Henry V. and Henry VI., the increasing subtlety of our legal system, and more particularly the notions introduced by the study of the civil law, appear to have occasioned the custom of granting charters in a new form. It appears to have been thought that the power of holding lands in succession, and the right of suing and being sued by a common name, could not in strictness be enjoyed, except by a body constituted for those very purposes by the king's grant. Hence originated charters or letters of incorporation, granted to the men or burgesses of towns jointly with the mayor, bailiff, or other chief officer; and thus municipal corporations in the strict legal sense were first constituted.

But previously to this time it is probable that a great change had taken place, in most towns, in the character of the class of 'men' or 'burgesses' to whom these charters were granted. As the privileges of burgess-ship became more valuable, additional difficulties

were thrown by the governing body in the borough in the way of its acquisition. While the old household right remained in some places, it was lost in others. In its stead, or by its side, arose the rights of freemen of a guild or trade; those of the holders of particular tenements, which alone were recognised as conferring on their occupant the title of burgess; those of freeholders in cities, counties of themselves, &c. And hence the variety of the old parliamentary franchise [PARLIAMENT], as members of parliament were elected by the burgesses. Hence the corporations, which were constituted by the charters of Henry VI. and Edward IV., were already very different bodies from the general mass of dwellers in a town. But close corporations, properly so called, were not established until the reigns of the Tudors, when the first 'governing charters' were granted. [BOROUGH.] By these new charters the powers of municipal government were usually vested in a mayor and common council: the latter consisting of councillors and aldermen; the former of whom were selected in various ways, by the whole of the council or the aldermen; the aldermen mostly nominated by and out of the rest of the council. In these bodies the control over the town funds, the civil and criminal jurisdiction of the town, and police authority within its limits, became vested. The freemen, as well as the commonalty, thus ceased to be members of the governing body; but the former retained the extensive pecuniary advantages which in many places belonged to them.

The causes of this revolution, and of the gradual change by which the municipal bodies became more and more exclusive in their character, are chiefly to be found in the parliamentary franchise enjoyed by most of the corporate boroughs. When the House of Commons became an important body in the empire, the crown, as well as the noblemen and the powerful individuals to whose estates the boroughs were contiguous, had a strong and direct interest in controlling the nomination of members. This was much more easily effected by the agency of select bodies, such as the corporations, than by influencing the votes of an independent community. Hence, while in the larger places the corporation, usually devoted to the interest of its patron, exercised a decisive or a strong authority in controlling elections, in many smaller boroughs the elective franchise became in effect confined to the corporation itself, by means of the freemen who were closely associated with it Thus the system of close corporations, established under the Tudors, acquired continually more strength and more exclusiveness. The governing bodies in the previous reign seem also to have assumed in many places the power, which has been since so liberally exercised, of admitting to the rights of freemen, or burgesses, whom they pleased, either by free gift or purchase. The great bulk of the property of corporations, both that enjoyed by them to their own use, and that of which they were trustees for charitable purposes, seems to have been acquired after the first charters of incorporation were granted, and previously to the Revolution.

In the reign of Charles II., when the corporate bodies in the larger towns had become for the most part attached to the Whig interest, and hostile to the court, they were attacked by the crown through the famous writs of quo warranto. These were writs issued out of the King's Bench to the municipal bodies, to enquire by what right they exercised their jurisdictions and enjoyed their franchises; and the object was to contest the validity of the ancient charters, or at least to terrify them into surrendering them into the king's hands, and receiving new ones from him. Many such surrenders were actually made, and new charters granted: these, however, were recalled by a proclamation of James II., and the old ones regranted or revived; and this proclamation was allowed, after the Revolution, to have the force of law. A few boroughs, however, did not accept the restoration of their charters, and remained without a corporation. From the period of the Revolution little or no change of importance took place in the constitution of the towns or their governing bodies, until the passing of the Municipal Reform Act in 1835. By this Act (5 & 6 Wm. IV. c. 76) the municipal franchise is made uniform all over the kingdom. In order to enjoy it, an individual must have occupied a house, warehouse, counting house, or shop, within the borough, for three years; and must have been rated to all poor rates in respect of such premises during the whole of such time; and must be enrolled on the burgess list, which is framed by the overseers of the parishes and revised every year by the mayor and assessors. He must also have resided within seven miles of the borough during that time. There are also provisions for the cases of successive occupancy and change of residence. These burgesses form the electoral body. They choose—1. The councillors; of whom the number is limited by the Act, according to the number of wards of which each borough consists (this number being also specified by enactment, and varying from one to sixteen). No person can be qualified as a councillor, or alderman, unless he is a burgess possessing a certain amount of property (1,000*l.*) or a rating at 30*l.* per annum, in boroughs having four wards and upwards; 500*l.*, or 15*l.* per annum, in boroughs not having that number. One third part of the councillors go annually out of office. 2. The council, i. e. the mayor, existing aldermen, and councillors, jointly elect every year the aldermen from among the qualified burgesses; half of whom go out of office every third year. 3. The councillors and aldermen together elect out of their own united body the mayor, whose office is annual. The mayor, aldermen, and councillors together form the council. The town-clerk, treasurer, &c. are appointed by the council during pleasure.

With regard to existing rights, freemen are

retained, so as to enjoy their rights of property and parliamentary franchise; but they can no longer be made by gift or purchase; and they must be inhabitants of the borough. The income arising out of the corporation property is to form a borough fund; which is to be applied, subject to existing claims, to the payment of salaries and other municipal expenses, prosecutions, maintenance of the gaol, &c. &c.; and if the fund be insufficient for these purposes, the council can impose a rate to supply the deficiency.

With respect to jurisdiction, the council of every borough now having a separate court of quarter sessions, or desiring to attain one, may apply to the king to retain or to acquire it; on which the king may, if he pleases, appoint a recorder to be paid by the town, being a barrister of five years' standing. This officer is to hold the court of quarter sessions of the peace, in which he is to be sole judge. Borough courts of record are to be retained as heretofore, and those in which a barrister of five years' standing acts as judge have power to try personal actions to the amount of 20*l*. The history of municipal corporations has been often written, and generally with much party spirit and unfairness. Those who wish to study it in the only authentic records, viz. charters and other documents, will find the most abundant collection of them, chronologically arranged, in Messrs. Merewether and Stephen's *History of Boroughs*, 1836.

Corps d'Armée. An army in the field is divided into *corps*, each consisting of two or more divisions, which are subdivided into brigades, and these again into battalions or regiments.

Corps Législatif (Fr.). The Lower House of the present French legislature, under the imperial government; constituted by senatus-consulte of 1857. The deputies are elected by universal suffrage for six years, in the proportion of one to 35,000 electors. It discusses and votes on projects of law and taxation, presented by government. These projects are submitted to *commissions*, i. e. committees. But any amendment which the commission may propose is referred to the government [CONSEIL D'ÉTAT], and without its approval cannot be submitted to the legislative body. A project finally adopted is next submitted to the SENATE [which see]. The session of the legislative body lasts three months: its sittings are public; but the public may be excluded on the demand of five members.

Corpus Callosum (Lat. *hard body*). In Anatomy, the great commissure, or band of transverse fibres, connecting the hemispheres of the cerebrum.

Corpus Christi (Lat. *body of Christ*). A festival of the Romish church, instituted by Urban IV. A. D. 1264, and celebrated on the first Thursday after Trinity Sunday, in honour of the Eucharist.

Corpus Juris (Lat. *body of law*). *Corpus Juris Romani*, the collection of the authentic works containing the Roman law as compiled under Justinian. The Corpus Juris comprehends the Pandects, the Institutes, the Code, and the Novels of Authentics, i. e. the latter constitutions of Justinian; to which, in some editions, are added a few issued by his successors. M. Beck has lately published at Leipzig the most complete edition. There are likewise publications styled *Corpus Juris Canonici*, *Germanici*, *Feudalis*, &c.

Corpus Luteum (Lat. *yellow body*). In Anatomy, a yellowish mass which is formed in a Graafian vesicle subsequent to the escape of an ovum. It is largest, most conspicuous, and lasting, after the escape of an impregnated ovum in the human subject.

Corpuscula Vermiformia (Lat. *worm-shaped bodies*). In Vegetable Anatomy, are synonymous with strangulated or necklace-shaped ducts, a kind of spiral vessel found chiefly in the knots and contracted parts of stems.

Corpuscular Action. The power or influence which the minute particles, or atoms, or *corpuscles* of matter, exercise on each other, and which is the cause of all chemical changes.

Corpuscular Mechanism. That branch of mechanical science which is concerned with the phenomena of cohesion. These phenomena indicate some relation between the centres of the particles cohering. The exact nature and cause of this relation is not known; but if it could be ascertained as clearly as the law of gravitation, we should at once be able to determine precisely the result of any position which we may give to the particles of bodies. Meanwhile, we have to content ourselves with a careful observation of all secondary laws of action.

Corpuscular Philosophy. A system of physics, known also as the Atomic Philosophy, in which all the phenomena of the material world are explained by the arrangement and physical properties of the corpuscles or minute atoms of matter. A doctrine of this sort was anciently taught in Greece by Leucippus and Democritus, from whom Epicurus borrowed the idea of monads or atoms, which he regarded as the ultimate principles of all things. These monads in the Epicurean theory had the properties simply of hardness and gravity; and hence the gases, which have assumed so much importance in modern chemistry, were not taken into account. This theory forms the subject of the magnificent poem of Lucretius, *De Rerum Naturâ*, which endeavours to make the Epicurean philosophy a guide of life. But the didactic vehemence of the poet failed to win a permanent reputation whether for his ethical or his physical philosophy. The latter was manifestly at variance with facts, and thus it came at last to be regarded as a wild dream. But the idea has been revived under a different form in the modern atomic theory, which asserts that matter may be resolved by division into certain ultimate elements, which again enter synthetically, in definite proportions, into the constitution of all things.

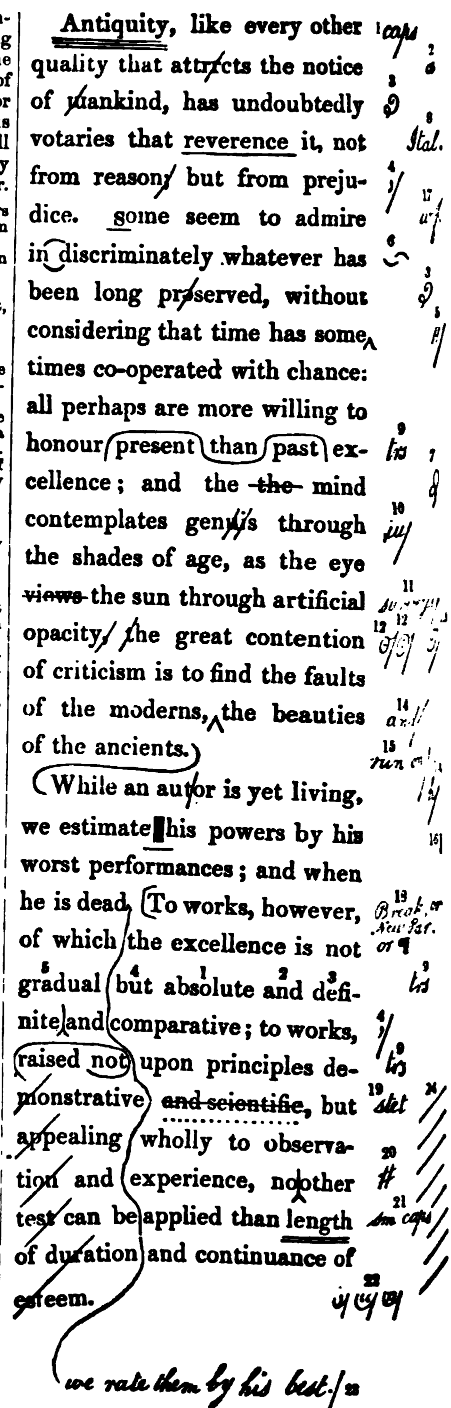
Correcting. In Printing, in the first instance, is the mode of amending and putting right the errors in the types made by the compositor; in the next, it is the correcting of the proof sheets of a work by the author or editor. The following explanation of the marks in general use, with the annexed specimen, will show the mode of correcting proofs in a way which will be clearly understood by the printer.

1. Where a word is to be changed from small letters to capitals, draw three lines under it, and write *caps.* in the margin.
2. Where there is a wrong letter, draw the pen through it, and write the correct one in the margin.
3. A letter turned upside down.
4. The substitution of a comma for another point, or for a letter put in by mistake.
5. The insertion of a hyphen.
6. To draw letters close together.
7. To take away a superfluous letter or word, the pen is struck through it, and a round top *d* made opposite, being the contraction of *deleatur*, to expunge.
8. Where a word is to be changed to Italic, draw a line under it, and write *Ital.* in the margin; and where a word is to be changed from Italic to Roman, write *Rom.*
9. When words are to be transposed, three ways of marking them are shown; but they are not usually numbered unless more than three are changed.
10. The transposition of letters in a word.
11. To change one word for another.
12. The substitution of a period or a colon for any other point. It is customary to encircle these points.
13. The substitution of a capital for a small letter.
14. The insertion of a word or letter.
15. When a paragraph commences where it is not intended, connect the matter by a line, and write in the margin opposite *run on.*
16. Where a space or a quadrat stands up and appears, draw a line under it and make a strong perpendicular line in the margin.
17. When a letter of a wrong size or of a different face is used, draw a line either through it or under it, and write opposite *w.f.*, for *wrong fount.*
18. The marks for a paragraph, when its commencement has been omitted.
19. When a word has been struck out, and it is subsequently decided that it shall remain, make dots under it, and write the word *stet* in the margin.
20. The mark for a space where it has been omitted between two words.
21. To change a word from small letters to small capitals, make two lines under the word, and write *sm. caps.* opposite. To change a word from small capitals to small letters, make one line under the word, and write in the margin *lo. ca.* for *lower case.*
22. The mark for the apostrophe; and also the marks for turned commas, which designate extracts.
23. The manner of marking an omission, or an insertion, when it is too long to be written in the side margin. When this occurs, it may be written either at the top or the bottom of the page.
24. Marks when lines or words are not straight.

The subjoined specimen when corrected would read as follows:—

ANTIQUITY, like every other quality that attracts the notice of mankind, has undoubtedly votaries that *reverence* it, not from reason, but from prejudice. Some seem to admire indiscriminately whatever has been long preserved, without considering that time has sometimes co-operated with chance: all perhaps are more willing to honour past than present excellence; and the mind contemplates genius through the shades of age, as the eye surveys the sun through artificial opacity. The great contention of criticism is to find the faults of the moderns, and the beauties of the ancients. While an author is yet living, we estimate his powers by his worst performances; and when he is dead, we rate them by his best.

To works, however, of which the excellence is not absolute and definite, but gradual and comparative; to works, not raised upon principles demonstrative and scientific, but appealing wholly to observation and experience, no other test can be applied than LENGTH of duration and continuance of esteem.


Antiquity, like every other quality that attrcts the notice of ɯankind, has undoubtedly votaries that reverence it, not from reason; but from prejudice. some seem to admire in discriminately whatever has been long prsserved, without considering that time has some times co-operated with chance: all perhaps are more willing to honour present than past excellence; and the ~~the~~ mind contemplates genuis through the shades of age, as the eye ~~views~~ the sun through artificial opacity, the great contention of criticism is to find the faults of the moderns the beauties of the ancients.

While an autor is yet living, we estimate his powers by his worst performances; and when he is dead, To works, however, of which the excellence is not gradual but absolute and definite and comparative; to works, raised not upon principles demonstrative ~~and scientific~~, but appealing wholly to observation and experience, noother test can be applied than length of duration and continuance of esteem.

Correction (Lat. correctio). In the Fine Arts. With the Italians the word, *correzione*, is used to denote an exact acquaintance with the different proportions of the parts of a body or design generally; but with us the term is applied to those emendations of inaccuracies or alterations of first thoughts, which they call *pentimenti*, to be seen under the surface of the finished picture, and which are accounted indications of its originality; a *pentimento* being a repentance or second thought.

Corridor. In Architecture, a gallery or open communication to the different apartments of a house.

Corrosive Sublimate. One of the chlorides of mercury, composed of 100 mercury + 36 chlorine. It is an acrid poison of great virulence: the stomach-pump and emetics are the surest preventives of its deleterious effects when accidentally swallowed; white of egg has also been found serviceable in allaying its poisonous influence upon the stomach. Its specific gravity is 52. It requires 20 parts of cold water, but only 2 of boiling water, for its solution. Corrosive sublimate has been called *bichloride*, *perchloride*, and *oxymuriate* of mercury; it is now commonly regarded as a compound of 1 atom or equivalent of mercury = 100, and 1 of chlorine = 36: its equivalent, therefore, is 136. *Calomel*, which is the other chloride of mercury, is tasteless, insoluble in water, and comparatively mild in its operation, acting rather as a purgative than as a poison: it consists of 2 atoms of mercury and 1 of chlorine, and is therefore called a *subchloride* or *dichloride* of mercury. [MERCURY; CALOMEL.]

Corrugate (Lat. corrugatus, from ruga, *a wrinkle*). In Zoology, the surface of an animal is so called when it rises and falls in parallel angles more or less acute.

Corrugated Iron. Sheet iron that has been rolled into a series of waves is known under this name; and in this form it is frequently used for temporary roofing, or for covering spaces in a definite manner. The waves are made in England from 5½ to 6 inches from centre to centre; in France they are, however, much increased, and are made to extend even to 13 inches. They are either impressed by the roller, or they are produced by hydrostatic pressure upon a movable upper block driven upon a lower one; but whatever system be adopted for the production of the waves, it is evident that none but the best iron will resist this action. There are at present no observations upon record to allow us to form an opinion on the strength given by the process of rolling, so that the practice of engineers in this matter is purely empirical. Railway bridges of from 10 to 15 feet span have been executed in this material; a roof of less than 25 feet span may be executed without a tie rod; beyond that span, however, it is necessary to guard against the lateral thrust and the bending of the tie rod in its own length. Corrugated iron is largely used for the panelling of houses sent out to the colonies; for which purpose its immunity from the attacks of the white ants, and its freedom from shrinking, give it a very decided advantage; but the conducting power of the metal renders it necessary to introduce some other substance between it and the weather. This inconvenience also applies to roof-coverings.

Corsair (Ital. corsaro). A term used in the south of Europe and some other parts for a pirate or his ship. The corsairs of Barbary were commissioned by their princes to attack the merchant ships of hostile countries.

Cortes (Span.). The old assembly of the estates in Leon, Castile, Arragon, and Portugal. These estates were framed, as elsewhere, of nobility, dignified clergy, and representatives of the towns. In Arragon they were presided over by a high officer, termed *justiza*, with powers in some respects sufficient to control the monarch. The origin of popular representation, in the cortes of the several kingdoms out of which that of Spain was finally formed, is assigned to a date as early as the twelfth century; but the deputies sent by the towns were irregularly summoned, frequently did not attend, and the numbers which appeared for each town frequently bore no proportion to the relative size of the different places. In the fourteenth century the power of the cortes seems to have been at its height, after which it gradually decayed, and under the government of Ferdinand and Isabella was reduced almost to a nullity. After the time of Philip II. the cortes of Spain were only occasionally convoked on the accession of kings, and their sittings were a mere form. In 1811, during the French invasion, they were convoked at Cadiz, and conducted the affairs of that kingdom during the war of independence. In 1814, Ferdinand VII. dissolved them, and declared all their decrees null. In 1820, the cortes met again, and adopted a new constitution; in 1821, the people of Portugal followed the same example: both constitutions were overthrown in 1823; the first by the French invasion, the latter by a counter revolution. The later events of Spanish and Portuguese history have again called these national assemblies into existence.

Corticifera, Corticiferi (Lat. cortex, *bark*, and fero, *I carry*). Those Polyps whose uniting fleshy substance is spread, like the bark of a tree, over a central calcareous or corneous axis.

Cortile. In Architecture, an open quadrangular or covered area in a dwelling-house, surrounded by the buildings or offices of the house itself. It means also a courtyard.

Cortina (Lat.). A term used in describing Fungi, to denote that portion of the velum which adheres to the margin of the pileus in fragments.

Corundum. A crystallised or massive mineral, composed of nearly pure anhydrous alumina. It is the hardest of all known substances, except the diamond, on which account it is much used for polishing steel and cutting gems. The term *Corundum* or *Common Corundum* is

generally confined to the opaque rough crystals and cleavable masses, generally of dingy colours and often dark, while the term *Emery* embraces the more or less impure, massive, granular and compact kinds, and *Precious Corundum* the transparent brightly tinted varieties which are used as gems; the blue variety under the name of *Sapphire*, the red of *Ruby*, the yellow of *Oriental Topaz*, and the violet of *Oriental Amethyst*. The crystals which show a bright opalescent six-sided star in the direction of the vertical axis, are called *Asteria* or Star-stone.

Hexagonal crystals of Corundum are found in Cumberland and in Wicklow. The principal supplies are obtained from China, Ava, the East Indies, and Asia Minor.

Corvée (Fr.). In Feudal Law, the obligation of the inhabitants of a district to do certain services, as the repair of roads, &c., for the sovereign or the feudal lord. Some species of corvée were performed gratis; others for a fixed pay, but generally below the value of the labour performed.

Corvette (Fr.). One of the smaller vessels of war, and ordinarily the command of a commander. It has flush decks, three masts, and one tier of guns—on the upper deck. The masts are square rigged. A corvette rarely carries more than 26 guns. The Navy at present (1865) comprises 26 steam corvettes and two without steam.

Corvus (Lat.). A Linnæan genus of birds, now the type of a family (*Corvidæ*), belonging to the Conirostral division of the *Passeres* of Cuvier; and including, with the Crows proper, the Rollers (*Coracias*) and Birds of Paradise (*Paradisea*).

CORVUS. In Astronomy, one of Ptolemy's constellations, in the southern hemisphere.

Corybantes (Gr. Κορύβαντες). In Grecian Mythology, certain fabulous beings, said by some to be the children of Apollo and Rhytia. They may be compared with the Curetes, Cabeiri, and Idæan Dactyls. (Thirlwall's *History of Greece*, vol. i. ch. iii.) The name (of which the origin is doubtful) was applied to the frantic priests of Rhea or Cybele, whose extravagances were taken as types of madness or frenzy in general.

Corycæum (Lat.). In ancient Architecture, an apartment in the gymnasia, attached to the Roman BALNEÆ [which see]. The name is derived from the Greek *κώρυκος*, *a leathern wallet* or *sack*, filled with bran and olive-husk, and which, when suspended at a certain height in the room, was swung backwards and forwards by the players.

Corylaceæ (Corylus, one of the genera). A natural order of arborescent or shrubby Exogenous plants, formerly called *Cupuliferæ*, inhabiting all temperate and some hot climates. They are distinguished from all European trees by their amentaceous flowers and peculiarly veined leaves; and from other plants by their apetalous superior rudimentary calyx; by their fruit enclosed in a husk or cup; and by their nuts, which contain but one cell and one or two seeds, in consequence of the abortion of the remainder. These plants are akin to *Betulaceæ* and *Salicaceæ*, from which they are distinguished by the presence of a calyx and the veining of the leaves. They are nearly allied to *Urticaceæ*, but differ from them in their many-celled ovary, pendulous ovules, and superior calyx. This order comprehends the Oak, Beech, Chestnut, and Hornbeam—well-known valuable forest trees; and the Hazel (*Corylus*), from which it takes its name.

Corymb (Gr. *κόρυμβος*). In Botany, a form of inflorescence consisting of a central axis, developing lateral pedicels, of which the lower are so long that their flowers are elevated to the same level as that of the uppermost.

Corymbiferæ (Lat. corymbus, and fero, *I bear*). One of the divisions of the great group of *Compositæ* admitted by Jussieu. It comprehends those plants which, like the *Chrysanthemum* and the *Achillea*, have the flower-heads furnished with a ray; as well as those which, like *Artemisia*, although destitute of a ray, are similar to such plants in the greater number of their characteristics.

Corymbus (Lat.; Gr. *κόρυμβος*). In ancient Sculpture, the cluster of ivy leaves, berries, garlands, &c. with which vases were encircled. It was applied also to that mode of dressing the hair among the Greeks, by which it was tied in a knot or cluster on the top of the head.

Corypha (Gr. *κορυφή*, *summit*). A genus of tropical Fan-leaved Palms, one of which, the Talipot palm, *C. umbraculifera*, found in Ceylon and Malabar, grows to the height of sixty or seventy feet. Fans made of the leaves are carried before people of rank by the Cingalese. The leaves are also used as umbrellas, and for tents; and by the natives as a substitute for paper.

Coryphæna (Gr. *κόρυς*, *a helmet*, and *φαίνω*, *I show*). A genus of spiny-finned fishes, so called from the head being crested like a helmet. It belongs to the Mackerel family (*Scomberoids*); and includes the true dolphin, or changeable coryphene (*Coryphæna hippuris*). The genus is now raised to the rank of a family, including, with *Coryphæna* proper, the sub-genera *Centrolopus* and *Leptopodes*.

Coryphæus (Gr. *κορυφαῖος*). The leader of the chorus in ancient dramas; by whom the dialogue between the chorus and the other actors of the drama was carried on, and who *led* in the choric song.

Coryphodon (Gr. *κορυφή*, and *ὀδούς*, *tooth*). A genus of fossil Perissodactyle mammalia, allied to *Lophiodon* and *Tapirus*. It has been found in the Eocene strata of England and France.

Coryza (Gr. *κόρυζα*). A copious running from the nose.

Cosecant of an Angle. The secant of the *complement* of that angle.

Cosine of an Angle. The sine of the *complement* of that angle.

Cosmetics (Gr. κοσμητικός). Remedies to remove freckles and pimples from the face, and to improve the complexion.

Cosmical (Gr. κοσμικός). This word occurs frequently in the ancient astronomy, in which it is used to denote a particular position of a planet or star, at its rising or setting, in respect of the sun. A star is said to rise *cosmically* when it rises at the same instant that the sun rises; and to set cosmically, when it sets with the sun. *Cosmical* is opposed to *acronycal*, which signifies that a star rises at the instant the sun sets, and vice versâ. The cosmical and acronycal risings of a star are invisible to the naked eye, because the light of the sun in the horizon effaces that of the star.

Cosmogeny (Gr. κοσμογονία). The science which treats of the origin of the universe. If we except the cosmogony of the Indians, the earliest extant is that of Hesiod, which is delivered in hexameter verse. The first prose cosmogonies were those of the early Ionic philosophers, of whom Thales, Anaximenes, Anaximander, and Anaxagoras are the most celebrated. In modern times, a *Theory of the World* has been produced by Burnet. We do not include in this list of cosmogonies the researches of modern geologists, or the systems to which they have led. They may be said to hold the same place in relation to the old cosmogoners, which the astronomer or the chemist occupies in reference to the astrologers and alchemists of ancient times.

The different theories which have been formed to account for the origin of the world may be comprehended under three classes: 1st. Those which suppose the world to have existed from eternity under its actual form. Aristotle embraced this doctrine; and conceiving the existing universe to be the eternal effect of an eternal cause, maintained that not only the heavens and the earth, but all animate and inanimate beings are without beginning. 2nd. Those which consider the matter of the universe eternal, but not its form. This was the philosophical system of Leucippus, Democritus, Epicurus, and indeed most of the ancient philosophers and poets, who imagined the world either to be produced by the fortuitous concourse of atoms existing from all eternity, or to have sprung out of the chaotic form which preceded its present state. 3rd. Those which ascribe both matter and its form to the direct agency of a spiritual cause.

Cosmography (Gr. κοσμογραφία). The science which treats of the construction, figure, and arrangement of all the parts of the world; and therefore comprehends astronomy, geography, and geology.

Cosmology. [Cosmogony.]

Cosmopolite (Gr. κοσμοπολίτης). A citizen of the world: one who makes the world his country.

Cosmorama (Gr. κόσμος, and ὁράω, *I see*). A species of picturesque exhibition, consisting of a number of drawings, generally about eight or ten, which are laid horizontally round a semicircular table, and reflected by mirrors placed opposite to them diagonally. The spectator views them through a convex lens placed immediately in front of each mirror. The pictures are illuminated by lamp-light; but the lamps are so placed that they cannot be reflected by the mirrors, and are therefore invisible to the spectator.

Coss. When algebra was first introduced into England, it was called the *Rule of Coss*; probably from the Italian *Regola di Cosa*, the *Rule of the Thing*; the unknown quantity being termed *cosa*, the thing. Hence *Cossic Art*, *Cossic Numbers*, &c., found in some old authors.

Cossacks. A people inhabiting those parts of the Russian empire which border on the northern dominions of Turkey, Poland, and the southern confines of Siberia. Both the name and origin of this people are involved in great uncertainty. They seem to have nothing Russian in their origin and character, and are probably a mixed Caucasian and Tartar race. They form a sort of independent republic, paying no taxes to Russia, but cheerfully contributing their numerous and valuable contingent of troops; and are well known as the most harassing light troops that ever exercised a predatory warfare in the train of any army.

Their dress is a short vest in the Polish style, large trousers of a deep blue colour, and a black sheepskin cap. Their arms consist of a sabre, long spear, musket, a pair of pistols, and a long whip, which they apply to their enemy as well as their charger's back. They are mostly members of the Russian Greek Church, and are described as a hospitable, generous, and disinterested people. Their numbers have not been estimated for nearly a century, when they amounted to 955,228 males.

Cost-book. In Mining usage, a book in which the names and shares of all the adventurers in a mine are entered, the legal transfer of shares being effected by a simple entry in the book.

Costa (Lat. *a rib*). In Botany, a term formerly confined to that bundle of vessels which passes directly from the base to the apex of a leaf; but which is better extended to all the main veins which proceed directly from the base to the apex, or to the points of the lobes.

Costal (Lat. costa). Belonging to the ribs.

Costardmonger (from costard, *a large apple*). An itinerant dealer in apples. The word is often written *costermonger*, and applied to hawkers and pedlars who sell fruit.

Costate (Lat. costatus, *ribbed*). In Botany, a term applied in two ways, in describing the venation of leaves: either to indicate the presence of but one rib, as in most leaves; or in speaking of cases where three or more ribs proceed from the base to the apex of a leaf, and are connected by cross veins. The latter are frequently called nerves, or nervures. If a leaf has its ribs all distinct from the very base, it is called *tricostate*, *quinquecostate*, and so on; but if the ribs are united at the base in a

distinct manner, the term becomes *triplicostate*, *quintuplicostate*, &c.

COSTATE. In Zoology, the surface of the whole or part of an animal is so termed when it has several broad elevated lines.

Costs (Fr. couter, *to cost*, from Lat. constare: Wedgwood). In Law, the expenses to which parties are put in the prosecution and defending of actions. Costs are to be considered either as between attorney and client, i.e. the expenses and fees which the attorney is entitled to recover from his client; or as between party and party, i.e. that portion of the expenses to which a successful party has been put in his suit, which he is entitled in certain cases to recover from the unsuccessful one. Costs in the latter sense are not given by the common law. The statute of Gloucester (6 Edw. I. c. 1, s. 2) first enacted that the demandant should recover from the tenant the cost of his writ, if successful; and that this provision should extend to all cases where a man recovers damages. By a liberal construction of this statute, the costs of the writ are understood as the costs of the action, and its benefit is extended to plaintiffs in most cases where they would have been entitled to damages before that statute. In other cases, the plaintiff is not entitled to costs, unless they are expressly given by statute. In assumpsit, covenant, and debt, if the plaintiff have a verdict, but the damages or debt and damages be under 40*s*., the judge may deprive him of any more costs than damages by certifying to that effect on the record, under 43 Eliz. c. 6, s. 2. In actions for assault and battery, and trespass, wherever the damages given by a jury do not amount to 40*s*., the plaintiff (by several statutes) is allowed no more costs than damages, unless the judge shall certify that assault and *battery* was sufficiently proved; or, in trespass, that the title to land came in question. The certificate may be granted at the trial, or within a reasonable time afterwards. Where, out of several issues, some are found for the plaintiff and others for the defendant, the plaintiff is now only entitled to costs on those issues on which he may succeed, and the costs of the defendant's issues will be deducted from his. The defendant's right to costs rests also on several statutes, principally 23 Hen. VIII. c. 15. Double and treble costs are given by some statutes in particular cases; and they follow by implication where double and treble damages are given. Double costs, in practice, mean single costs and one-half their amount in addition: treble, the same, with one-half of these last. Costs are *taxed* as between party and party by officers of the court; and recoverable by action, execution, or attachment. As between attorney and client, the attorney has a right of action for costs; but his bill is liable to taxation by officers of the court, under certain restrictions. Costs in equity are within the discretion of the court, except in certain cases; as where no answer is made to a bill exhibited, or an insufficient answer, &c.

Costume (Fr.). In Painting and Sculpture, this word has become used chiefly as a term denoting the particular sort of dress suitable to the subject, according to the time in which the action is supposed to have taken place; but the word has a more general signification, inasmuch as it includes the keeping of all the accessories, ornaments, utensils, &c. of such forms and colours as historical knowledge proves them really to have possessed.

In modern times painters have paid more attention to propriety of costume, as considerable knowledge on the subject has now been acquired, and egregious ignorance on the part of the painter is inexcusable; formerly, from a want of knowledge, accuracy was difficult, and the grossest improprieties were common. (Hope, *Costume of the Ancients*, 1812; Lacroix and Seré, *Le Moyen Âge et la Renaissance* &c. 1848–51; Meyrick's *Critical Enquiry into Ancient Armour &c.* 1842; Planché's *British Costume*, 1846; Shaw's *Dresses and Decorations of the Middle Ages*, 1843; and Strutt's *Dress and Habits of the People of England &c.* 1842.

Costus (Arab. gosth). A genus of *Zingiberaceæ*, the roots of some of which are used as preserves. The Costus of the ancients, however, was the root of a composite plant formerly called *Aucklandia Costus*, now known as *Aplotaxis Lappa*.

Cotangent of an Angle. The tangent of the *complement* of that angle.

Cotarnine. A basic substance derived from narcotine by oxidising agents.

Coté Droit, Coté Gauche. [DEPUTIES.]

Coterie. A French word, supposed to be derived from the Lat. quot, *how many* signifying literally a society or company. In the thirteenth or fourteenth century, when merchants were about to embark in any enterprise, they formed a coterie or company, each contributing his *quota* of goods or money, and deriving his *quota* of profit. But the term soon acquired a more extended signification, being applied to any exclusive society in which interesting subjects (chiefly literary and political) are discussed, each member being supposed to contribute his *quota* or share of information.

Cotham Marble. A variety of Lias Limestone of a pale grey colour, which when cut at right angles to the bedding displays dendritic markings bearing a fanciful resemblance to landscapes and ruins; for which reason it has, also, received the names of *Ruin* or *Landscape Marble*. It is found in the Rhætic (or Penarth beds) of Cotham and other places, near Bristol.

Cothurnus (Lat.; Gr. κόθορνος). In classical Antiquities, the high buskin worn by tragic actors to increase their apparent height: thence used, metaphorically, by ancient writers to signify the tragic art.

Cotise (Fr. coté, *side*). In Heraldry, a diminutive of the bend, being one-half the width of the bendlet: generally borne in couples, with a bend or charges between them. A bend, fess, &c. between two cotises, is termed *cotised*.

Cottabus (κότταβος). A celebrated Greek game. It consisted in throwing wine from cups into little basins of metal suspended in a particular manner, or floating in a large vessel of water; so that dexterity might be shown in throwing it without spilling, in producing a particular sound, &c.

Cottage Allotments. Portions of ground allotted to the dwellings of country labourers for the purpose of being cultivated by them as gardens. Sometimes these allotments are placed adjoining the dwellings, in which case they are more commonly called *cottage gardens*; but at other times they are placed at a distance from the cottage, and form small portions of a large enclosure; and to this kind of cottage garden the term *allotment* is more properly applied than to the other. The object in both cases is to enable the cottager, by growing vegetables and roots of various kinds, not only to supply his own family, but to keep pigs, rabbits, poultry, &c. Such being the uses of cottage allotments, the advantage of each cottage having its garden surrounding it, instead of at a distance, is sufficiently obvious. In the latter case, the cottager must necessarily lose much time in travelling backwards and forwards from his house to his garden; and his wife and children will often be prevented from employing themselves in it. In such a garden he cannot grow fruits, because they would be comparatively unprotected; nor can it be worth his while to grow flowers in a place where they would not prove an ornament to his dwelling. On the supposition that the cottager has his pigsty close to his dwelling, the food for the pigs must be brought home from the allotment; and the manure made by them must be carried out again. It is well known to all persons of any experience on this subject, that by far the most valuable part of the manure made by the cottager, such as house-waste, &c., may be included under the term *liquid manure*; and this, when the allotment is at a distance, may be considered as entirely lost, the cottager being without either convenience or time for carrying it out. In point of usefulness, therefore, a cottage allotment in a field, at the distance of a furlong or less from the cottage, is not worth half what it would be if adjoining the dwelling; while in point of enjoyment to the cottager, and of ornament to the roadside, it is hardly worth anything. On the other hand, the labourer who has a lease of a comfortable cottage surrounded by a garden, even if the latter should not be larger than the eighth part of an acre, may grow good and wholesome vegetables and fruits; he may have his live stock of pigs, poultry, rabbits, and bees; he may ornament his house front and the borders of his walk with shrubs and flowers; and he has the wages of his labour for the purchase of those comforts and luxuries which his garden does not afford. The time, it is to be hoped, is not far distant when the humblest country labourer will possess such a cottage and garden; but it is necessary that the country labourer should acquire previously a taste for these comforts by seeing them possessed by others of his class; and for this we must look partly to the country labourers themselves, partly to the government for the establishment of a system of universal education which shall raise the taste of the humblest part of society, and partly to the humanity and sympathetic feeling of the landed proprietors; because it is to them we must look, in the first instance, for building the cottage and accompanying it with garden ground.

Cottier System. This term has been applied to that tenure of land in which the labourer rents portions of the soil from the owner, and in which the price of the occupancy is determined by competition and not by custom. It was characteristic of Ireland before the famine, and is not yet wholly extinct. An analogous kind of tenancy exists in India, though it does not appear that the exceptional evils of the Irish practice have ever been represented in the Eastern peninsula.

As the tenancy was annual, the privilege of occupancy was put up to auction, and the pressure of population caused a vehement competition, the peasants offering many times over the value of the rent. Of course such a rent could not be paid, but all that could be extracted from the tenant was got, and hence his condition reached no higher than the barest subsistence on the cheapest food.

In the great majority of cases where the labourer is also the cultivator of the soil for his own profit or subsistence, his interest in the land is at least permanent, i. e. he is either a proprietor, as in Flanders, Belgium, France, and other countries, or he enters into a perpetual lease with the lord of the soil, as is the case with the metayer tenant.

When a capitalist engages to rent land, he is but partially affected by competition. In other words, he would not choose to hold at rent except he had reason to believe that he would procure the ordinary rate of profit on his outlay. But when the person who bids is exposed to the full effect of a demand for what is a necessary of life, the optional employment of his labour and such capital as he may possess is taken away; he must either outbid his neighbours or starve. This was the case with the cottier biddings. Hence it has been stated that a cottier has been known to bid at an auction 450*l.* a year for a farm not worth 50*l.* (*Lord Devon's Commission*, quoted by Mr. Mill, vol. i. p. 391, edit. 1862.)

Cotton (Span. algodon, Arab. go'ton, algoton: Wedgwood). A species of vegetable wool, which envelopes the seeds of various species of *Gossypium*, especially of *G. herbaceum*, of which there are many varieties. The kinds of cotton met with in the market are usually designated by the names of the places from which they are brought; but practically, they are all divided into the two great classes of *long-stapled* and *short-stapled*. Its goodness depends on its colour, and the length, strength, and fineness

of its fibre. The general chemical characters of cotton are those of *lignin*. It is peculiarly susceptible of combination with certain metallic oxides or bases; whence the facility with which it is locally dyed, as in the process of *calico printing*.

COTTON. A term of Engineering which expresses the small pieces of iron driven to retain the keys or wedges in their position.

Cotton Manufacture. In modern times cotton has attained to an importance among vegetables second only to that of corn, if we regard the number of persons engaged in its culture and in its manufacture. The manufacture of cotton wool into articles of use and ornament appears, indeed, to have been carried on in India from the remotest antiquity; but it has not made any very great progress in the East, and obtained no footing worth mentioning in Europe till the last century.

The truth is, that this industry, though it now affords employment and subsistence to many hundreds of thousands of persons in this and other countries, is almost wholly a consequence of discoveries and inventions made in Great Britain and the United States, since the middle of last century. Previously to that period the manufacture was everywhere confined within the narrowest limits. Owing to the difficulty of separating the wool from the seed, its price, so long as this operation had to be performed by the hand, was naturally high; while the cost of its spinning and weaving by the wheels and looms in use previously to 1760 added so much to the price of cloth, that cotton articles were suited only to the use and demand of the better classes of society; and it seems unreasonable to suppose that the manufacture could have been materially extended without a greatly increased facility of production. But in this respect the most signal and extraordinary improvements have been made. The *Jenny* invented by Hargreaves in 1767 enabled one person to spin 80 or 120 threads with about the same facility that a single thread had been previously spun. The jenny, however, was fitted only to spin the softer descriptions of yarn, or that used as *weft*, being unable to give the thread the firmness and hardness required in the yarn used as *warp*. But this deficiency was soon supplied: the genius of Arkwright completed what Hargreaves had begun, by inventing the spinning frame—that wonderful piece of machinery which spins any number of threads of any degree of fineness and hardness, leaving to man merely to feed the machine with cotton, and to join the threads when they break! Nearly at the same time that the spinning department was thus wonderfully improved, Dr. Cartwright, a clergyman of Kent, invented the power-loom, a machine which has already gone far to supersede weaving by the hand. While these extraordinary inventions were being made, Watt was perfecting the steam engine, and was thus not only supplying the manufacturers with a new power applicable to every purpose, and easy of control, but with one that might be placed in the most convenient situations, and in the midst of a population trained to industrious habits.

Still something remained to complete this astonishing career of discovery. Without a vastly increased supply of the raw material at a lower price than it had previously brought, the inventions of Hargreaves, Arkwright, and Watt would have been of comparatively little value. Luckily, what they did for the manufacturers, Mr. Eli Whitney did for the cotton growers. He invented a machine by which cotton wool is separated from the seed with the utmost facility and expedition. Previously to 1790 the United States did not export a single pound weight of raw cotton. In 1792 they exported the trifling quantity of 138,328 lbs. Whitney's invention came into operation in 1793; and in 1794, 1,601,760 lbs., and in 1795, 5,276,306 lbs. were exported! And so astonishing has been the growth of cotton in the interval, that in 1849 the exports from the United States amounted to the prodigious quantity of 1,026,602,269 lbs.!

The chief source of cotton wool up to the year 1862 was the Southern States of the American Union, the supply from this region being abundant and the quality good. Since the civil war, however, commenced, this supply has been greatly reduced, the quantity imported in the year 1864 being little more than one-fifteenth of that sent in 1860. The gap has been partly filled by a great increase from the East Indies, Egypt, and Brazil; and within the last two years China has sent a considerable contribution. It is even said that cotton is being cultivated largely, and becoming an important branch of agriculture in several parts of Southern Europe.

A cotton mill is probably, all things considered, the most astonishing triumph of skill and ingenuity. All the various operations, from the carding of the wool to its conversion into a texture as fine almost as that of the gossamer, are performed by machinery. Each of the workmen at present employed in a cotton mill superintends as much work as could have been executed by 200 or 300 workmen sixty or seventy years ago, and yet, instead of being diminished, the numbers employed have increased even in a still greater proportion! It would be curious to investigate how many persons in the Old and New Worlds directly depend for subsistence on the inventions and discoveries of the founders and improvers of this great manufacture. They certainly amount to several millions, while there is scarcely anyone in any country, however remote or barbarous, who is not indebted to them for an increase of comfort and enjoyment.

The subjoined statement, taken from the circular of Messrs. George Holt and Co., cotton brokers at Liverpool, dated December 31, 1864, gives an account of the progress of the import of the raw material into Great Britain from 1820 to 1864 inclusive:—

Statement of the Number of Bales of Cotton Wool consumed in the United Kingdom from 1820 *to* 1864, *both inclusive, with the Average Weight of the Bale in each Year.*

Year	Bales in Thousands	Average lbs. per Bale	Year	Bales in Thousands	Average lbs. per Bale
1820	467	258	1843	1,367	379
1821	499	258	1844	1,429	381
1822	545	267	1845	1,574	385
1823	560	275	1846	1,586	387
1824	605	273	1847	1,158	381
1825	600	278	1848	1,464	394
1826	511	294	1849	1,590	396
1827	675	297	1850	1,515	388
1828	782	297	1851	1,668	396
1829	745	294	1852	1,861	397
1830	832	298	1853	1,904	400
1831	858	306	1854	1,967	394
1832	891	311	1855	2,101	399
1833	880	326	1856	2,183	408
1834	919	330	1857	2,031	416
1835	954	333	1858	2,174	417
1836	1,012	343	1859	2,967	424
1837	1,057	346	1860	2,532	429
1838	1,207	346	1861	2,364	426
1839	1,114	343	1862	1,186	381
1840	1,251	367	1863	1,378	370
1841	1,192	367	1864	1,566	350
1842	1,160	375			

Manchester, or rather Lancashire, is the grand seat of the English cotton manufacture; and next to it Cheshire, Nottinghamshire, the West Riding of Yorkshire, and Cumberland are its principal seats. Glasgow with the surrounding district is the seat of the manufacture in Scotland. In Ireland it is principally confined to Belfast; but there it is of very limited dimensions, and is said to be rather on the decline.

The cotton manufacture has for the last three years (1862–64) suffered under very serious depression in consequence of the failure of supply from the southern portion of the United States. The circumstances which led to the civil war are so recent and so vast that there is no space to enter into them, even were a disquisition on these subjects relevant to the question before us.

The growth of the cotton manufacture was reciprocated by the extension of cotton planting in those states of the American Union in which slavery was instituted and protected. It was no doubt unfortunate that any large portion of British industry should be dependent on a single country for its supply of raw material, and particularly so when we consider the nature of the labour by which it was procured, and the manifest disagreement which prevailed between the two political sections of the Union on the question of slavery and its extension. When at last war broke out, it was confidently expected by those who sympathised with either side, that the struggle would be short, and end either in the submission or in the independence of the South. But these predictions have been falsified by events, and meanwhile the supply from these regions, except to a very unimportant extent, has been suspended. Nor does it seem likely, whatever be the result of the war, that the production of cotton in the semi-tropical parts of North America will ever recover its former proportions. In any event the settlement of the country must be a work of time, and in the interval other countries will occupy at least a portion of the trade, once almost a monopoly of the American planters.

The demand for cotton wool has called out prodigious activity in many parts of the world. Cotton has an exceedingly wide geographical range, and is naturally diffused over all the warmer countries of the globe. When once capital is employed in its systematic cultivation, and machinery is supplied for cleansing the seeds from the wool, there is little doubt that this staple will be largely grown, and that it will be imported from an increasingly wide area.

There is no reason to fear that the manufacture, seeing how nearly it affords an absolute necessary of life, will not revive and flourish as fully as before its partial but serious depression; and we may venture on predicting, that, great as has been the suffering induced by the temporary deprivation of the raw material, there is nothing which is more likely to civilise the world, and promote the best interests of many nations, than the general demand which has sprung up for this commodity, and the fullness with which a response has been given.

Cottus (Dor. Gr. κόττα, *a head*). A genus of spiny-finned fishes; so called on account of the large size of the head. It includes two British species, viz. the Father-lasher (*Cottus bubalis*) and the Sea Scorpion (*Cottus scorpio*); both of which are dreaded by fishermen on account of the painful and dangerous wounds which they inflict by means of the spines with which the gill-covers are armed.

Cotunnite. A native chloride of lead found in the crater and in some of the more recent lava of Vesuvius. Named after a medical man of Naples.

Cotyledon (Gr. κοτυληδών). In Botany, the seminal leaf of a plant. This organ forms a part of the embryo, and nourishes the plumule and radicle at their first period of developement, before they are able to subsist upon the organisable matter absorbed by the latter from the earth. Exogenous plants have generally two cotyledons, Endogenous plants generally one only; but there are exceptions in both cases. The latter class of plants seldom elevate their cotyledon above ground, and never convert it into a green leaf-like body, but usually leave it behind them within the integuments of the seed; the former frequently raise their cotyledons above the soil in the form of small green leaves, as in the garden radish; but there are very numerous exceptions to this, as in the pea, the oak, the chestnut, &c.

Cotyledons. This term was applied by Aristotle to designate the sucking-cups of the arms of the Dibranchiate Cephalopods. In Comparative Anatomy, the cup-shaped vascular productions of the chorion in Ruminants, serving the office of a placenta, are so called.

Cotyliform (Gr. κοτύλη, *a cup*). In Botany, a term used in describing the general form of organs to denote a rotate figure with an erect limb.

Couch. A layer or heap of barley, moistened and prepared for malting; also the name of that part of the malting floor on which the barley is spread out.

Couch Grass. A kind of grass, botanically known as *Triticum repens*, with underground running rhizomes, forming a very troublesome weed in cultivated ground, whether garden or farm.

Couchant (Fr.). In Heraldry, a term applied to a beast when represented as lying on the ground.

Couching. In Agriculture, clearing land from Couch grass, which is effected by first pulverising it, and then, in very dry weather, collecting the couch by harrows, or by a horse rake, such as that used for collecting stubble, and which so applied is called a *couch rake.*

Couching. One of the operations to restore vision in cases of *cataract*: it consists in depressing the opaque lens, so as to remove it out of the axis of vision.

Cough. This term is applied to a spasmodic action of the respiratory organs, occasioning a sonorous expulsion of air from the lungs: it is very commonly symptomatic of other affections; and some nosologists have considered that it is always so, and never idiopathic. Many cases of cough depend upon the extension of *catarrh* to the trachea and bronchiæ, which become loaded with mucus or phlegm, the efforts to expel which constitute coughing. Others are perhaps referable to a vitiated secretion; and others to imperfect action of the absorbents, by which the natural mucous secretion remains and accumulates in the air-vessels, and by evaporation becomes inspissated and irritating; this appears to be one of the causes of the dry cough to which old people are subject. The treatment of catarrhal cough consists in allaying irritation by demulcents, such as mucilaginous drinks and lozenges, which, acting upon the glottis, sympathetically affect the trachea and its ramifications: amongst these, extract of liquorice, and lozenges made of it and equal parts of gum tragacanth, are very effectual. Stimulants and full diet are to be avoided, and inflammatory symptoms carefully guarded against; for these are often brought on by the violence of the cough. It is not unfrequently necessary to call in the aid of sedatives, expectorants, and aperients. Amongst the former, small doses of Dover's powder (opium and ipecacuan), or of equal parts of it and extract of henbane, are very serviceable; and it is not uncommon to observe a troublesome cough disappear after a brisk dose of physic. An emetic will also sometimes effect its cure; so that coughs have been by some considered as symptomatic of a vitiated state of stomach and bowels. Where a cough periodically returns at night, and is not inflammatory, a dose of laudanum sufficient to induce sound sleep will often, as it were, break the habit and relieve it. Sedatives, conjoined with stimulating expectorants, such as squills, ammoniacum, benzoic acid, &c., are often effectual in relieving the coughs of old age; and in these, and what are called nervous coughs, much relief is experienced by administering mild opiates in the form of lozenges, so that they may pass gradually over the neighbourhood of the affected part, in consequence of the slowness with which they are dissolved in the mouth and swallowed: lozenges of sugar, liquorice, or tragacanth, with about two grains of extract of poppies in each, are useful in such cases. Where coughs are symptomatic of inflammatory action, of asthma, &c., they often require modes of treatment which have more particular reference to their exciting causes.

Coulter (Lat. culter). In Agriculture, an iron blade or knife inserted into the beam of a plough, for the purpose of cutting the ground and facilitating the separation of the furrow-slice by the ploughshare. [Plough.]

Coumaric Acid. An organic acid derived from coumarin, by the action of alkalies. It crystallises in lustrous colourless plates.

Coumarin. A crystalline odoriferous principle extracted from the Tonka Bean, which is the seed of the *Dipterix odorata.*

Council (Lat. concilium). In Church History, an assembly of prelates and other spiritual persons for the regulation of ecclesiastical matters. Such councils are either national or œcumenical; the latter being those in which the whole body of the clergy throughout the world is represented, and are convened for the settling of points of universal interest.

The Roman Catholics hold that the decisions of œcumenic or general councils are infallible, and for the most part allow their superiority to the popes themselves. This superiority was first asserted at the council of Pisa, in which the two reigning anti-popes were deposed; it was confirmed by the councils of Constance and Basel or Basle. Since that time the popes have been very unwilling to convene a general council, and that of Trent is the only one that has assembled in later times.

Some Protestants allow the authority of general councils in matters which do not contradict Scripture, and attach great importance to the four first councils; viz. of Nice, Constantinople I., Ephesus, and Chalcedon. But they maintain that a general council can only be called by a temporal prince, while this prerogative is assigned by the Romanists to the pope.

Council, Privy. The principal council belonging to the king of England. In its origin it appears as a small permanent committee, or minor council, consisting of members selected by the king himself out of the great council of the kingdom. The latter body is supposed to have been originally composed of all the immediate tenants of the crown; and it was occasionally summoned as late as the reign of Richard II., and seems then to have comprised nearly all the prelates, nobles, and

bannerets of the kingdom *et autres sages.* When the privy council was formed out of it, has not been ascertained. It appears in early rolls of parliament as the permanent or continual council; and as its powers under the Plantagenet kings were very extensive, so parliament exercised considerable influence in controlling the appointment of its members, although always vested in the crown as an essential prerogative. The privy council under these sovereigns usually consisted of the five great officers of state, the two archbishops, and from ten to fifteen other individuals, spiritual or temporal. It sat continually as a court, both to expedite the executive part of the administration, and to provide equitable relief in cases submitted to it, thus controlling the courts of common law. (Sir F. Palgrave's *Essay on the Original Authority of the King's Council*, 1834; and the Preface to the *Records of the P. C.*, edited by Sir H. Nicolas.) There were also under the Tudors councils, portions of the privy council, exercising like powers in various parts of England. The increasing power of parliament on the one hand, and the extended equitable jurisdiction of the lord chancellor on the other, gradually encroached upon the ancient dignity and importance of both the councils. The Star Chamber and Court of Requests, dissolved in the reign of Charles I., were both committees of the privy council.

Privy councillors are made by the king's nomination, without patent or grant. Their number, having greatly increased under the Tudor princes, was restricted by Charles II. to thirty; but soon became indefinite again, and has so continued. They are entitled *right honourable.* No privy councillors attend except such as are specially summoned. The privy council continues in office six months after the demise of the crown, unless sooner dissolved by the successor. The separation of the functions of the privy council from the more important political duties of the Cabinet, which is in truth only a committee, without recognised legal powers, of the Privy council, seems to have been chiefly effected in the reign of William III.

The jurisdiction of the privy council is of several sorts: 1. The king in council may issue proclamations binding on the subject, if consonant to the laws of the land. He issues also orders in council for the temporary regulation of various matters relating to trade and international intercourse. 2. The privy council has power (which, however, has been long out of use) to enquire into offences against government, and commit offenders to take their trial according to law. 3. Appellate jurisdiction in the last resort from all his majesty's dominions, except Great Britain and Ireland, is vested in the privy council. By 3 & 4 Wm. IV. c. 41, enlarged by 6 & 7 Vict. c. 38, a judicial committee of the privy council is constituted, to which are entrusted appeals from the Ecclesiastical and the Prize and Admiralty Courts, and courts in the plantations abroad, and all other appeals which might previously have come before the king in council. The judicial committee may direct feigned issues to be tried at common law. The lord president of the council is the fourth great officer of state. The office must probably have been cotemporaneous with the origin of the council itself; but the title is comparatively recent. It was created by Henry VIII., and revived by Charles II. in favour of the earl of Shaftesbury. Of late years the business of his office has been greatly increased by the control vested in it over the grants for public education.

Council of State. A political and judicial body of very indefinite powers in the French monarchy, both before and since the Revolution. As reorganised by Napoleon I. it became the most important body in the state. It now, under the second empire, consists of members of the imperial family, nominated by the crown: a president, vice-president, presidents of sections (which are six: justice, *contentions*, home affairs, public works, war, finance); forty to fifty ordinary and nearly forty extraordinary councillors.

Counsellor (Lat. consiliarius, Fr. conseiller). In Law, a person retained by a client to plead his cause, who is also said to be counsel for him. For the regulations by which the admission to practise as a counsellor is restricted in England, see BARRISTER.

Count (Lat. comes, *a companion*). A title of dignity in most of the Continental states of Europe, equivalent in rank to the British earl and the German *graf.* Under the Byzantine empire, the forty-three great military commanders were styled *dukes* (duces); of these ten were known by the higher title of *counts* or companions. (Gibbon, *Roman Empire*, ch. xvii.) Under the first two races of the Frank kings, this title of *count* was given to officers of various degrees, and was at first attached to the office, and not to the person; but in the progress of time, when feudalism had introduced inheritance instead of election as a fixed rule in succession, it became subject to the same law as the higher titles of kings and dukes, and conferred hereditary privileges on its possessor. [FEUDALISM.] The term *count* has in most of the states where it is in use degenerated into a mere title, to which no political importance is attached. Though the title *count* has never been introduced into Britain, the wives of earls have from the earliest period of its history been designated as *countesses.*

COUNT. In Law. [DECLARATION.]

Counter Mark. In Numismatics, a stamp frequently seen on ancient coins, often obliterating part of the inscription or the impression. The counter mark is generally a figure or inscription; and some antiquaries have considered that its use was designed to increase the value of the money; others that it was only struck on money taken from an enemy.

Counter-tenor. In Music, the same as CONTRALTO [which see].

Counterfort (Fr. contrefort). In Architecture, a buttress, or pier, built against or at right angles to a wall to strengthen it, so as to enable it to resist a particular thrust.

Counterguards (Fr. contre-garde). In Fortification, are small ramparts with parapets and ditches, to cover some part of the body of a place, to which they are made parallel. They are generally made before the bastions, sometimes before the ravelins.

Countermines. Are mines or galleries excavated by the defenders of a fortress, to intercept the mines and destroy the works of the besiegers. [Mines.]

Counterpart (Fr. contrepartie). In Law, when the parts of an indenture are interchangeably executed by the several parties, that part which is executed by the grantor is termed the *original*, and the rest are *counterparts*. If each part is signed by all parties, they are duplicate originals.

Counterpoint (Fr. contrepoint; Ital. contrapunto). In Music, the art of writing music in several distinct parts. The name is derived from the circumstance of the notes being placed one against or over the other on the score. [Music.]

Counterpoise. In Mechanics, a mass of metal connected with an instrument or machine, either for the purpose of giving steadiness, or diminishing the pressure on some particular point, as, for example, the pressure of the pivots of a transit-instrument on its supports.

Counterproof. In Engraving, an impression obtained from another impression, whilst it is still wet from the copperplate, in which the design is in the same direction as in the plate itself. It is made chiefly for the sake of investigating the state of the plate; and of some prints the counterproofs are more valuable than the prints, where the drawing from the picture has not been reversed on the copper; these, however, are amongst the curiosities of the trade of printsellers.

Counterscarp (Fr. contrescarpe). In Fortification, the wall of the ditch on the side farthest from the body of the work.

Countersign. A watchword given daily by the commander of an army, in order that friends may be distinguished from enemies by their knowledge of it. Before an enemy, sentries require the countersign from everyone who approaches their post.

Countersign. In Diplomatics, the signature of a public officer to the charter of a king, prelate, &c. by way of certificate. *Obtulit, recognovit, relegit et subscripsit*, are common additions, in charters of the middle ages, to the name of the countersigner.

Country. In Mining, the name given by miners to the rock enclosing a mineral vein containing ore. Thus a granite or a slate *country* are spoken of according as the vein occurs in granite or slate.

County. A county is in England that district of territory which was anciently subject to the government of an earl or ealdorman, from whose Latin title *comes* the term is derived. The English word corresponding to county was *shire*, meaning division, which is therefore not applied to such counties as were originally distinct sovereignties; such as Kent, Essex, Sussex, Middlesex, Suffolk, Norfolk.

The division of the kingdom into counties, which, in common with many other of our earlier institutions, is commonly attributed to Alfred, though it was probably of a date far anterior, was in ancient times chiefly of use in marking the limits of different jurisdictions. To each county belonged a county court, which it was the duty of the thanes and other freeholders to attend and do suits at, though it seems the thanes only took part in the administration of justice. Such court was originally held by the earl and bishop, the latter assisting in respect of the ecclesiastical jurisdiction belonging to the court; or in their absence by the sheriff, upon whom the right to preside in the county court, either in person or by deputy, as well as the other civil functions of the earl, have long since devolved. Considered in its judicial character, the county court was the great court baron or civil court of the county, and was originally competent to the trial of almost all civil actions arising within such county. The criminal jurisdiction belonging to the county, which is now vested in the magistrates at quarter sessions, was anciently exercised by the sheriff in his tourn. [Tourn.] The boundaries of a county serve also to mark the limits of the jurisdiction, both civil and criminal, which other courts or judges exercise within each county severally by commission from the crown [Venue]; and within these limits also are confined the ministerial functions of the sheriff as executor of the writs awarded by either of the great courts.

The division into counties is also for some purposes, particularly that of representation in parliament, political; and it is in the county court that the election of members of parliament takes place, and that other political acts of the men of the county are done; for county meetings convened and presided over by the sheriff are, properly speaking, holdings of the county court. What has been said of counties in England applies without qualification, save as to the time of the institution, to Wales, and with very little qualification, to Ireland and Scotland; the most important point of difference being the greater extent of the jurisdiction and power of the sheriff in the latter country. There are in England 40 counties, in Wales 12, in Scotland 32, and in Ireland 32.

A County Palatine, of which description there are now two in England, viz. Durham and Lancaster, is a county in which all jura regalia, i. e. the whole rights of sovereignty in judicial matters, belonged to the earl of such county; but these privileges are now reduced to the possession of courts of their own, corre-

sponding in number and jurisdiction to the Queen's courts at Westminster, whose jurisdiction is not excluded by theirs, and whose writs may be so framed as to run within the limits of the county palatine.

County Court. The County Court properly so called is a court baron, not of record, for civil causes, held by the sheriff in each county. This court could formerly hold pleas where the debt or damage was under 40*s.*, except by virtue of the writ called of *justicies*, which was a special precept to the sheriff to do justice between parties in the same manner as it might be done in the courts of Westminster. But by the 9 & 10 Vict. c. 95, a great extension of jurisdiction was given to the county courts; and they were completely remodelled. That statute has been amended by several subsequent statutes, down to 19 & 20 Vict. c. 108, by which the expense of these courts, hitherto borne by the suitors, was almost wholly transferred to annual vote of parliament. It may be generally said that they have exclusive jurisdiction in cases of debt or damage up to 20*l.*, concurrent up to 50*l.*, and by consent to any amount: subject, however, to certain provisions for removal to the superior courts where required. Many other branches of jurisdiction (equitable, insolvent, &c.) have been by degrees conferred on these important tribunals.

County Rate. [RATE.]

Couple of Forces or Pressures. In Statics, a *couple of pressures* (or *forces*) denotes two equal pressures having precisely opposite directions, but applied at different points of a body. According to the ordinary method of the composition of parallel forces, the resultant of such a system would be a parallel force having the intensity zero, and applied at an infinite distance. In reality, two such forces have no single resultant; their tendency being to produce rotation about an *axis* perpendicular to their plane. Couples, therefore, require a distinct treatment. The theory of couples, their composition, resolution, &c., was first given by Poinsot (*Éléments de Statique*), and now constitutes an essential branch of statics. The distance between the parallel forces is called the *arm of the couple*, and the product of either force into the arm the *moment of the couple*. It can be readily shown that the statical effect of a couple is unaltered by transportation to a parallel plane, or by any variation in the magnitude and direction of its forces and arm, provided the moment remains the same. On this account, a couple, like a simple force, may be conveniently and perfectly represented by a line OA drawn from any origin O perpendicular to its plane, having a length OA proportional to its moment, and a direction such that to an observer at A, looking towards O, the rotation which it is the tendency of the couple to produce shall appear to be direct like the hands of a clock. Such a line, limited in length and definite in direction, is called the *moment-axis* of the couple, in order to distinguish it from the *rotation-axis*, which is unlimited in length and simply indicates the direction of the plane of the couple. This mode of representation being adopted, the composition and resolution of couples follow the same laws as those of concurrent simple pressures. Thus, if we regard the moment of a couple as positive or negative, according as the rotation would be direct or retrograde, we may say: *The resultant of two or more coaxal couples is another coaxal couple whose moment is the algebraical sum of the moments of the components.* Again: *The moment-axis of the resultant of any two couples is the diagonal of the parallelogram whose sides are the moment-axes of the components.* The above two properties of couples being established, the general problem of the composition of any number of pressures acting on a body in different directions becomes greatly simplified. [FORCES, COMPOSITION AND RESOLUTION OF.]

Couple of Rotations or Angular Velocities. Two equal and opposite rotations around parallel axes. The term was introduced by Poinsot (*Théorie de la Rotation des Corps*), who first fully investigated the composition and resolution of rotations. A couple of rotations is easily shown to be equivalent to a translation of the whole body in a direction perpendicular to the plane of the rotation-axes, with a velocity equal to that which either axis possesses in virtue of its rotation about the other. The common velocity of all points of the body is expressed by the product of either of the equal angular velocities into the distance between the axes. This distance is called the *arm of the couple*, and the product its *moment*. A couple of rotations, therefore, may be represented perfectly by a single line, exactly as in the case of a couple of pressures; and the composition and resolution of both kinds of couples follow precisely the same laws. Velocities of rotation and translation are, as it were, reciprocal—a *couple* of either is equivalent to *one* of the other.

Coupled Columns. In Architecture, columns half a diameter apart. The façade of the Louvre, and St. Paul's Cathedral, contain some of the best examples of this style of intercolumniation.

Coupling. In Machinery, this term is applied to any contrivance for connecting or disconnecting the different parts of a machine, and particularly for effecting the longitudinal connection of shafts. Hook's *Joint* (*Dictionary of Science*) is one of the most ingenious contrivances of this kind. (Buchanan's *Practical Essays on Mill Work &c., with Additions*, by Tredgold and Rennie.)

Coupling Box. A strong iron cylinder, by which the shafts of machinery are connected.

Couriers (Fr. coureur, from courir, Lat. currere, *to run*). A name given to the bearers of public despatches or private intelligence by express. The employment of couriers is of great antiquity. By the Persians they were styled ἄγγαροι, by the Greeks ἡμεροδρόμοι, and by the Romans *cursores*. The duties of the ancient couriers seem to have been the same as

those of the moderns, and were performed chiefly on horseback. In the middle ages couriers were known by the appellation trottarii, or *trotters*; and hence perhaps originated the English term *running footmen*, of whom history makes mention in the seventeenth and eighteenth centuries.

Course (Lat. cursus). In Architecture, a continued level range of stone or brick of the same height throughout the range of the elevation of a building.

COURSE. In Navigation. The angle which the ship's track makes with all the meridians between the place left and the place arrived at.

Course of Crops. [ROTATION OF CROPS.]

Coursers, Cursores (Lat. *runners*). An order of birds, including those which are disabled from flight by the restricted developement of the wings, but which possess superior powers of running from the compensating size and strength of the legs: the ostrich, rhea, cassowary, emeu, and apteryx are examples of this order.

Courses. On Shipboard, are the sails sustained by the lower masts, viz. the foresail, mainsail, and spanker. They are the largest and most powerful sails on board.

Court Baron. A Court Baron, so called either from the lord or baron who presided over it, or from the freemen, in ancient times also called barons, who were its suitors and judges, was a court having its origin apparently in notions of a patriarchal jurisdiction. properly and in the first instance incident to every manor, in which it was held by the lord of the manor or his steward, who, assisted by the freeholders of the manor, there decided on the purely civil controversies which arose between them. A court baron also belonged to every HUNDRED and COUNTY [see those titles]; and in many cases also to particular franchises or lordships, which might include several manors. Courts baron, from the inferiority of their judges, and from the defects of their jurisdiction, which a party might defeat by removal of the cause to a higher tribunal, have long fallen into disuse; except in manors of ancient demesne, where the jurisdiction was, and in some respect still is, in the first instance exclusive, the lord of such manors having once been the king; and except in manors containing land of copyhold or customary tenure. [COPYHOLD.]

Court of Enquiry. In Military Law, is held under the crown's prerogative (as established in 1820 in the case of Colonel Horne) to enquire into the conduct of military or naval officers in special cases; distinct, therefore, from courts martial. Among some of the most remarkable on record are: that on the convention of Cintra, 1808; that on the riots at Bristol, 1831. Proceedings are conducted by the judge-advocate, or his deputy, before a tribunal nominated by the crown.

Court Plaster. Black silk varnished over with a solution of isinglass, which is often perfumed with benzoin.

Court, Supreme, of the United States. The highest judicial authority in that commonwealth, consists of seven judges, nominated by the president during good behaviour with the advice and consent of the senate. Its original jurisdiction is defined by the constitution, and extends to a variety of cases in which the provisions of the constitution itself, or federal interests, come in question: including suits to which the federation is a party; suits between two or more states; and between a state and foreign states. It has also an extensive appellate jurisdiction.

Courts Martial. In Military Law, derive their authority from the annual Mutiny Act, which empowers the crown to issue commissions to commanders of bodies of troops to convene, and authorise inferior officers to convene, such courts. Courts martial are: 1. General; 2. District or Garrison; 3. Regimental, and for bodies less than a regiment. In general courts martial, the judge-advocate-general settles the charges against the accused. In other courts martial, this is done by the convening officer. The charges are for offences against some article of war or clause of the Mutiny Act. The question of guilty or not guilty, or any other finding of the court, is decided by a majority of voices: it is considered that by the custom of the service the president has no casting vote, and that equality of votes implies acquittal. But the president has a casting vote as to the sentence. The sentences of general courts martial are subject to confirmation by the crown. General courts martial alone are competent to try commissioned officers, and certain civilians subject to the Mutiny Act; or to pass sentence of death or penal servitude. Naval courts martial are general only. (19 Geo. III. c. 17, sec. 9, and 22 Geo. III. c. 23.)

Courts of Justice. Are divided by the rules of English law into courts *of record* and *not of record*. The former have power to make up their acts and judicial proceedings in the form technically called a *record*, as evidence of their judgment. All courts having power to fine or imprison are said to be impliedly courts of record; but this seems questionable.

The courts termed Superior are divided into those of Law, Equity, Ecclesiastical, Maritime, Prize or International, and Courts of Appeal and Error. They are:—

Three Superior Courts of Common Law [COURTS, SUPERIOR], being:—

Superior Courts of Equity. [CHANCERY.]

The Ecclesiastical Courts. [ECCLESIASTICAL COURTS.]

The Court of Admiralty. [ADMIRALTY.]

The Prize Court. [ADMIRALTY.]

The Courts of Bankruptcy. [BANKRUPTCY.]

The Courts of Error and Appeal are:—

1. The Exchequer Chamber, from the Superior Common Law Courts. [EXCHEQUER CHAMBER.]
2. The Privy Council, and Judicial Committee of the Privy Council, which are

Courts of Appeal from the Ecclesiastical Courts, Admiralty, and also from the decisions of various Colonial Judicatures.

3. The High Court of Parliament. [PARLIAMENT.]

Inferior Courts are numerous, both of record and not of record; being for the most part local jurisdictions of very various extent and authority. To these belong the Courts of Conscience and Requests, Courts Baron, Hundred Courts, Borough Courts, and County Courts, in which the sheriff presides.

Courts, Superior. The three superior common law courts of England are the Courts of Queen's Bench, of Common Pleas, and of the Exchequer. For the origin and history of each court, and its peculiar jurisdiction, see those separate heads.

For several centuries, by means of various admitted fictions, these three courts have exercised a concurrent jurisdiction in all personal actions [ACTIONS]; and the practice of all three is, in material points, the same. They sit, during term, at Westminster. The different branches of jurisdiction of the three superior courts are: 1. That of the full court in *banc*, during term only, when four judges sit together in each: 2. Of the Practice or Bail Court (created by 1 Wm. IV. c. 70, s. 1, in which a single judge disposes of some less important matters of business); 3. Of a single judge at chambers, where also points of minor importance in the conduct of a cause are decided and directions given; 4. Of the master or prothonotaries, officers to whom various matters of fact, as computations, &c., are referred; 5. Of the judge at Nisi Prius and on the circuit for the trial of issues in fact; 6. Of the sheriff in each county, who may be considered as an officer of the superior courts for the purpose of trying issues directed to him under 3 & 4 Wm. IV. c. 42.

The course of proceeding in the superior courts is either formal or summary. Formal proceeding, in personal actions, is the regular course of a trial, whether the issue, or question tried, be one of fact or law. The party complaining, or plaintiff, having brought the defendant into court in person, or constructively, by preliminary *process*, entitles his *declaration*, or the form of statement of his grievance [PLEADING], as of one of the three courts, the same in which the writ for commencement of the action is said to be *returnable*. The defendant then pleads; and all the subsequent pleadings, or preparatory statements in writing, are entitled of the same court: in which also the record, or parchment roll containing the authentic entry of the whole proceeding, is made up. The question eventually raised between the parties will turn out to be either of law, or of fact. The former being raised on what is termed a *demurrer* [PLEADING], is argued at Westminster before the full court, and the judgment in law is conclusive of the issue. If the question be of fact, it must be tried by a jury. If the pleadings are dated at London or in Middlesex, as in *local* actions they must be if the question arise in those districts, and as in *transitory* actions they may be in all cases [PLEADING], the jury will be summoned accordingly, and the case tried before a judge of the court in which the action is brought, at NISI PRIUS [see that head], either during term or in the sittings after term. If, on the other hand, the date, or *venue*, as it is termed, be in any other county, the parties proceed to trial at the assizes (the plaintiff bringing down the record from Westminster, by which means it is in his option to proceed to trial or not). In this case a jury is summoned in like manner before the judges of assize, by virtue of their commission of oyer and terminer. In some special cases, trial at bar is granted on application; in which case the cause is tried by a jury before the full court, at such time as the court may fix for convenience. If a party imagines himself to have grounds for being dissatisfied with the result of a trial, as, that the judge has summed up the evidence improperly to the jury, or that material testimony has been illegally rejected, he may move the court at Westminster for a new trial, or to set aside the verdict, according to the circumstances of the case; and such motion is made before the full court in term. On the issue of the trial judgment is awarded, declaring that the plaintiff either has, or has not, entitled himself to the remedy prayed; and costs are given with the judgment; after which the successful party may issue out execution, unless there be an appeal by writ of error, which only lies on matter of law arising on the face of the proceedings.

Summary proceedings are of very miscellaneous character; and are by affidavit, motion, rule *nisi* (i. e. unless cause is shown against the rule on a certain day; when, if no cause, or insufficient cause, is shown, the rule is made absolute, and if made absolute, followed by demand of performance, and this performance enforced by means of attachment for contempt of court). By these means the courts have extensive authority to give directions and enforce conditions during the progress of a suit. Among summary proceedings may also be enumerated the leave given, on motion, to amend various formal defects in pleadings.

Courtesy (Fr. courtoisie, Ital. cortesia). It was at the courts of princes and great feudatories that the minstrels and troubadours of the middle ages especially delighted to exercise their art; and it was there, also, that the peculiarities of chivalrous life and manners were chiefly exhibited. Hence *courtesy* was a general term, expressive of all the elegance and refinement which the society of those times had attained; in fact, it was synonymous with all the gentler parts of chivalry itself; and in this sense it is used both by the early trouvères and romancers, and also by poets of a later age,

when affecting the use of chivalrous language, as in the first lines of the great poem of Ariosto:—

> Le donne, i cavalier, l' arme, gli amori,
> Le *cortesie*, l' audaci imprese io canto.

The transition from this wider meaning to that in which it is now employed is obvious enough. It may be sufficient to refer to the very ingenious theories of Signor Rossetti respecting the secret meaning attached to this word as well as to others of frequent occurrence in the poems of the Italian canzonieri of the thirteenth and fourteenth centuries. (*Inferno di Dante*, 1827, vol. ii. p. 430 &c.)

Couseranite or **Couzeranite.** A silicate of lime and alumina with potash and soda, the principal localities of which are in the department of Ariège (formerly Couserans) in France, where it is found in a black schist in short square or octagonal prisms. It is, also, met with in rounded, bluish-black crystals, near Pouzac, on the right bank of the valley of Bagnères-de-Bigorre.

Coussinet (Fr. *a cushion*). In Architecture, the crowning stone of a pier from which the arch springs, or that which lies between the capital of the impost and under the sweep of the arch; its bed is level below and inclined above, receiving the first rise or the spring of the arch. This word is also used for the ornament in the Ionic capital between the abacus and the echinus, which serves to form the volute, and is thus called because its appearance is that of a cushion, or pillow seemingly collapsed by the weight above it: it is bound by a strap or girdle, called the *balteus*, from its resemblance to that article of dress.

Covariant. A quantic so derived from a given system of quantics as to be equal, to a factor *près*, to the quantic similarly derived from the linearly transformed system of quantics, and that in virtue of the *same* relation between the new and old variables. If the linear transformation be unimodular, we may say that a quantic is a covariant when the operations of derivation, by which it is obtained from the given system, and linear transformation are *commutative*. This characteristic property is also expressed, briefly, by saying that the relation of a covariant to the system of quantics is unaffected by one and the same linear transformation of all the facients. The given system of quantics may, of course, consist of a single individual.

Mr. Cayley, the discoverer of covariants, has in his more recent researches (*Phil. Trans.* 1854) given another definition which we will illustrate by an example. Let $(a_0, a_1, a_2, a_3)(x, y)^3$ be any binary cubic; then the results of the two operations

$$y\frac{d}{dx} \text{ and } a_0\frac{d}{da_1} + 2a_1\frac{d}{da_2} + 3a_2\frac{d}{da_3}$$

performed upon it are obviously identical, and a similar relation will be true for all binary quantics, so that we may indicate by $\left[y\frac{d}{dx}\right]$ the operation which when performed upon the coefficients of a quantic is identical with $y\frac{d}{dx}$ applied to its variable part. This being understood, a *covariant* of a quantic may be defined as any function of its variables and coefficients which, like the quantic itself, is reduced to zero by each of the two operators

$$\left[y\frac{d}{dx}\right] - y\frac{d}{dx} \text{ and } \left[x\frac{d}{dy}\right] - x\frac{d}{dy};$$

and an *invariant* as any function of its coefficients alone which possesses the same property. Thus

$(a_0a_2 - a_1^2)x^2 + (a_0a_3 - a_1a_2)xy + (a_1a_3 - a_2^2)y^2$

is a covariant of the above cubic; it is in fact its Hessian, and

$a_0^2a_3^2 + 4a_0a_2^3 + 4a_3a_1^3 - 3a_1^2a_2^2 - 6a_0a_1a_2a_3$

is an *invariant*, in fact its discriminant.

Covariants are distinguished according to their dimensions in the coefficients of the original quantic as well as according to their degrees in the variables; thus a covariant of the second dimension in the coefficients and of the fourth order in the facients would be termed a *quadricovariant quartic*.

The geometrical applications of the theory of covariants are most important. In general a ternary or quaternary covariant, equated to zero, represents a curve or surface whose relation to a given system of curves or surfaces is of a permanent character and unaffected by any transformation of coordinate axes. Dr. Salmon's *Lessons on the Higher Algebra* will be found to be a useful treatise on the subject: the identity of the above two definitions is established at p. 75 of that work. For further particulars with respect to the formation of covariants, see HYPERDETERMINANT.

Cove. This term is applied to the hollow part of a moulding, or to a concave depression on a rectilineal surface.

COVE. An inlet on a rocky coast. It is a term nearly synonymous with *harbour*; the word *cove* being generally, though not always, used when the indentation on the coast is too shallow or narrow to admit first-class vessels.

Covelline, Covellinite or **Covellite.** A sulphide of copper, which occurs in the form of a sooty deposit or network, like a spider's web, around the fumaroles of the crater of Vesuvius.

Named after the discoverer, Signor Covelli.

Covenant (from Lat. convenio, through Fr. convenant). In History, the famous bond of association adopted by the Scottish Presbyterians in 1638. [COVENANTERS.]

COVENANT. In Law, an engagement under seal to do or to omit a direct act. Covenants are of many different species, as, in fact and in law, implied and express, &c.; and, according to their subject-matter, or express stipulation, they are binding respectively on the heirs, executors, and assigns, or executors and assigns only, of the covenantor.

COVENANT. Is also a form of action, which lies where a party claims damages for breach of a covenant or contract under seal.

Covenanters. The great body of the Scottish people, at the era of the Reformation, adopted the presbyterian faith and polity as established by Calvin at Geneva, and as introduced into Scotland by Knox. But it never succeeded in gaining permanently the affection or countenance of the court. On the contrary, the successive monarchs by whom Scotland was governed from the Reformation in 1560 till the final establishment of presbytery as the national church in 1690, did all in their power to undermine and destroy it. But though, owing to royal favour, episcopacy, or *black prelacy*, as it was called by the presbyterians, occasionally predominated, it was as often superseded by presbytery. The latter, after having been for some time displaced by prelacy, gained the superiority in 1592; from which time till 1606 it was established as the national religion. At this latter period, however, episcopacy obtained the mastery, which it enjoyed for upwards of thirty years. It continued, however, as obnoxious as ever to the great body of the Scottish people; and matters at length came to a crisis. Charles I. having introduced the High Commission Court, and having attempted also to introduce the Book of Canons and the Liturgy or Service Book, public indignation was unequivocally expressed, particularly in Edinburgh, where a very serious tumult took place (July 1637) on a Sunday, when an attempt was made (according to royal proclamation) to read the liturgy in the church of St. Giles. Supplications against the liturgy issued from all classes of the people, and from the great majority of municipal corporations, and were carried by the principal men of the kingdom to be presented to the privy council. These supplications were not attended with success; but the supplicants were not to be driven from their purpose. The most effectual means were adopted to keep up an organised opposition to the royal procedure. Four *tables*, as they were called, were formed. One table consisted of nobility, another of gentry, a third of clergymen, a fourth of burgesses; thus representing all ranks and classes of the people. There was also a general table, composed of representatives from the four subordinate tables, which received suggestions from these, and decided on what steps it was necessary to adopt. One of their first acts was the production of the *Covenant*; and hence all those who either then or afterwards subscribed it or gave in their adherence to it, were denominated *Covenanters*.

The Covenant to which we now refer, is in many respects a renewal of the Covenant which was subscribed in the year 1580, 1581, and 1590, but so modified and enlarged as to embrace the circumstances under which the church was placed at the crisis under review. It inveighed not merely against popery, as the former Covenant had done, but 'against the danger of the true reformed religion (that is, the presbyterian faith and polity as established in 1592), of the king's honour, and of the public peace of the kingdom, by the manifold innovations and evils' so generally prevalent. The subscribers also profess, and 'before God, His angels, and the world, solemnly declare, that, with their whole heart, they agree and resolve all the days of their life constantly to adhere unto and to defend the aforesaid true religion.' (See the *National Covenant* appended to the *Westminster Confession of Faith*, p. 483, edition 1815.)

These expressions with many others showed that the persons by whom they were uttered were in earnest, and that nothing could satisfy them but the abolition of the High Commission Court, and the revocation of the canons and liturgy. They insisted on the questions between them and the king being immediately submitted to a free General Assembly of the Kirk and to parliament.

Meanwhile the supplicants repaired from the country to attend a solemn meeting in Edinburgh, at which the Covenant (March 1, 1638) was solemnly subscribed and sworn by the nobility, gentry, clergy, and burgesses. Commissioners were immediately despatched with copies of it throughout Scotland; and in a few weeks every district of the country, with some partial exceptions, submitted to the Covenant.

Charles, seeing the formidable position and influence of the Covenanters, was at length willing to recall the liturgy and the canons, and to make considerable concessions for the sake of peace. But it was too late: nothing would satisfy the Covenanters but the extirpation of prelacy. Nay, so far did they carry their condemnation of the bishops, that they had not only preferred an accusation against them as the authors of the innovations, but had, meanwhile, applied for an interdict, prohibiting them from having a seat in the privy council. The prelates, indeed, finding that their influence was nearly gone, voluntarily withdrew from the council; and the king, after much temporising and intrigue, found himself obliged to agree to the meeting of the General Assembly on the terms which the Covenanters had proposed. The Assembly met at Glasgow in November, and continued its sittings (for thirty days) as its inalienable right, even though the royal commissioner, the marquis of Hamilton, had meanwhile declared the meetings dissolved. It not only annulled the canons, liturgy, the High Commission Court, and other innovations, but it abolished episcopacy itself, as having been from the first both illegal and unscriptural. (*Acts of Assembly*, 1638.)

The proceedings of this assembly were so obnoxious to Charles that when the Supplication voted at the conclusion of its meetings was presented to him he declined to return any answer. This injudicious conduct brought matters to a crisis. Both parties prepared for war, a step which the Covenanters, who always professed the greatest loyalty, adopted with reluctance. So devoted, however, were the people to what they regarded as a righteous cause, that the expense on the side of the

Covenanters was defrayed by a general voluntary assessment. In raising both men and money, the clergy took an active part; and contributions for carrying on the war were levied by them from their respective flocks to an extent scarcely credible. Of the hostilities that ensued it is unnecessary here to say more than that, though they gained the only battle that was fought, they lost no time in making proposals of peace. These proposals were accepted by the king; and a treaty was concluded (June 1639) four months after the commencement of the war. Of this treaty, the most important clause was that, as the king would not ratify the enactments of the Assembly of Glasgow, and as the Covenanters would not annul them, a free General Assembly should be held in the ensuing month of August, and a parliament immediately afterwards; to the decision of which courts every dispute between the contending parties was to be referred. This Assembly met accordingly; but its proceedings displeased the king more, if possible, than those of its predecessor; and fearing that the parliament might exhibit a similar spirit, he lost no time in proroguing it. But nothing could now arrest the march of public sentiment; and in the parliament which met in June 1640, every enactment of the General Assembly respecting the Covenant and Presbytery became the law of the land.

Thus the Covenanters, after a struggle of three years, saw their favourite ecclesiastical polity established, and the validity and authority of the Covenant recognised by the legislature. Their history from this date becomes that of the Presbyterian church in Scotland, and is interwoven with the annals of their country. [PRESBYTERIANS.] Charles, offended with the triumph of the Covenanters, again declared war against them; but after a short campaign, unfavourable to the royalists, peace was restored (1641). When the civil war broke out in England, the Covenanters, on the repeated and urgent application of the parliament, made common cause with them, and took up arms for the third time against royal authority. But along with a civil league the Scots succeeded (1643) in carrying a religious covenant, known in history under the name of the *Solemn League and Covenant*; the main object of which was to accomplish uniformity of religious doctrine and church government in both kingdoms. Nor was this object long in being, so far, attained; a presbytery, as it existed in Scotland (having obtained the sanction of the famous Assembly of Divines at Westminster, 1643–9, and having been afterwards ratified by the English parliament), was recognised as the national church of both portions of the empire. Presbytery, however, was in England rather an experiment than a permanent institution, and it rapidly declined, having been, to a considerable extent, superseded by Independency. At the Restoration episcopacy triumphed over both these forms, and has since been retained in the Established Church of England. By a sweeping Act, called the *Act Rescissory*, passed in 1661, all the parliaments that had been held since 1640 were declared null and void; thus rendering invalid those Acts, in confirmation both of the Covenant and of presbytery, to which the late king had assented, and which Charles II. himself had sworn to maintain. From this period the Covenant may date its decline. It continued, indeed, to be regarded as sacred by those who would submit to no compromise, and who, in consequence, were objects of persecution during the reigns of Charles and his brother James. Nay, so far did some of these parties carry their opinions, that they did not regard any person entitled to homage as king unless he had *covenanted*, or affixed his signature to the Covenant. The party by which such a principle was professed are known in history under the name of *Cameronians*, a body which, though now much reduced in numbers and importance, and who have moderated or changed their sentiments on this subject as well as on others, still exist in Scotland as a distinct religious sect. [CAMERONIANS.] At the Revolution, when presbytery was revived in Scotland and established as it now obtains, no mention was made of the Covenant either in the General Assembly or inferior courts, and it now exists only as a matter of history.

Covered Way. In Fortification, a space left between the glacis and the edge of the ditch all round the work. The glacis forms its parapet; it is provided with a banquette for musketry defence, and is often palisaded to prevent an enemy taking it by a sudden rush. Here the garrison assemble before making sorties. It is generally about eleven yards broad.

Coversed Sine of an Angle. The *versed sine* of the complementary angle.

Coverts. In Ornithology. The *lesser coverts* (*tectrices primæ*) are small feathers which lie in several rows on the bones of the wings. The *greater coverts* (*tectrices secundæ*) are the feathers that lie immediately over the quill-feathers and the secondaries. The *under coverts* are the feathers that line the inside of the wings.

Coverture. In Law, the legal condition of a married woman. [MARRIAGE, LAW OF.]

Covey (Fr. couvée, *a brood*, from couver, *to hatch*). An old bird with her young ones; but generally used to designate a number of partridges or other game. It also in some countries signifies a cover for game.

Covin. In Law, a compact between two or more, to deceive or prejudice others in certain cases; as, if tenant for life or in tail conspire with another party, to the intent that such party may recover lands held by the tenant to the prejudice of him in reversion.

Cow-keeper. A person whose business it is to keep a stock of cows for supplying the public with milk and cream. The principal cow-keepers of the metropolis have their esta-

blishments in the suburbs, where they are connected with pasture fields, in which the animals may be turned out a portion of nearly every day throughout the year. The cows are fed in the house with grains, hay, and other kinds of nourishing food; and as the animals get air and exercise, their milk may be considered wholesome. There are many cow-keepers, however, in the metropolis, who keep cows in confined back houses, and even in dark cellars; and, while they feed them with rich food, give them no exercise at all: hence the milk of such cows cannot be considered as wholesome.

Cow-pox. This disease was proposed in the year 1798 as a substitute for, and preventive of, the small-pox, by Dr. Jenner; and subsequent experience, as well as the extent to which the inoculation of it, or *vaccination*, as it is called, is carried throughout the civilised world, furnish well-grounded hopes of the ultimate extinction of one of the severest visitations of the human race. Small bluish vesicles, surrounded by inflammation, elevated at the edge and depressed in the centre, and containing a limpid fluid, occasionally appear upon the teats of the cow, the animal being at the same time somewhat indisposed: a similar disease is transferable under certain circumstances to the hands of the milkers; and persons who had so received it were found to be in many instances unsusceptible of small-pox, both natural and inoculated. There is a disease of the horse's heel called *grease*, which appears to have produced similar effects upon the hands of farriers, and is perhaps the origin of the cow's disease: but it is from the latter animal that the *matter* is most certainly effective, and from which it is transferred to the human race, where it produces similar vesicles; and the fluid of these may again be transferred with the same effects from one human subject to another. Whether by continuous circulation through human subjects the *virus*, as it is called, gradually loses its preventive efficacy, is an important question, and one upon which there are differences of opinion; but it would probably be more safe if more frequently derived from its original source upon the cow's teat. It seems useless here to discuss the various objections which have been raised, and the suspicions which have been thrown out against the permanent efficacy of this preventive, since the most extended and unbiassed experience of the most skilful observers seems amply to have proved that *when the vesicle has gone through its regular stages*, the person is afterwards, during the whole period of life, unsusceptible of natural and of inoculated small-pox, the exceptions to this statement being so few as either to be referable to imperfect vaccination, or to idiosyncrasy; and though it is not pretended that cases of small-pox after vaccination are as rare as of small-pox after small-pox, yet it is well known that the latter do occur, and, in short, that there is no rule without exceptions. In doubtful cases vaccination should always be repeated; and as no inconvenience results from a repetition of its inoculation, and the disease is not infectious by effluvia, it may be performed at certain intervals or may even be tested as to its efficacy by *variolous* inoculation; although to the latter there are certainly serious objections, if we look to its ultimate extermination. In inoculating patients for the cow-pox the matter should be taken from a healthy child, at about the sixth or the eighth day, at which time the vesicle is well formed: and it should be immediately transferred upon the point of the lancet from the vesicle to the arm, and inserted by a small oblique puncture under the cuticle, one place in each arm being quite sufficient. If this direct mode cannot be followed, the virus intended for inoculation may be transferred between two pieces of plate glass, one of which is slightly indented for its reception; when slid over each other they are air-tight, and the edges may be secured by a strip of moist gold-beater's skin, or very thin bladder. If it is necessary to moisten the virus, this should be done with as small a portion as possible of tepid water, not exceeding the temperature of 100°. Lancet points which have been *armed*, as it is called, cannot be long depended upon, and are apt to be rusted and to irritate the arm. About the third day after inoculation the puncture generally becomes red and elevated, but the periods of its incipient progress are very uncertain; it then continues to enlarge and become vesicular; and is in full perfection about the eighth or ninth day, at which period also the surrounding circle of inflammation or *areola* is at its height. About the eleventh or twelfth day this declines, and the centre of the vesicle becomes brown, and gradually dries up into a dark-brown circular scab, depressed in the centre. During the progress and scabbing off of the vesicle great care should be taken to avoid all external injury; all irregularities in its progress should also be carefully watched; and if much inflammation comes on spontaneously two or three days after inoculation, and especially if suppuration ensues, the probability is that the operation has failed; and in all cases where there is the least doubt, the inoculation should be repeated, although, if one of the vesicles has gone through the above described progress, the failure or irregularity of the other is of less consequence. The cow-pox is seldom attended by any symptoms requiring medical aid; but generally there is a slight drowsiness and febrile symptoms, with some restlessness, and occasionally sickness, about the second and third days; but these symptoms are immaterial to the preventive efficacy of the virus, which can only be judged of by the appearance and progress of the vesicles, to which therefore it is necessary to pay close attention.

Cow-tree. The Palo de Vaca of South America, *Brosimum Galactodendron*, sometimes called *Galactodendron utile*. The name is also applied to *Tabernæmontana utilis*, *Clusia Galactodendron*, and *Ficus Saussureana*.

Cowhage, Cowitch. This term is generally applied to the hairs or spiculæ which cover the seed pods of the *Mucuna pruriens*, a climbing perennial plant, which is a native of the West Indies. An electuary formed by dipping the pods into treacle, syrup, or despumated honey, and then scraping them, has long been used as a vermifuge; but it is often a very troublesome remedy, from the excessive itching which it produces when it touches the unprotected skin, and there are other more effectual means of expelling worms.

Cowries. Small shells brought from the Maldives, which pass current as coin in smaller payments in Hindustan, and throughout extensive districts in Africa: 100 are equivalent to a penny.

Coxswain. In Maritime language, is the steersman in a boat. He has the command for the time being of the boat's crew.

Coypu. A Rodent quadruped; the *myopotamus* of zoologists. [NUTRIA.]

Crab. [CANCER.]

CRAB. A machine for raising weights, consisting of a horizontal barrel, usually turned by a winch handle, and having a rope wound round it, which, when the weight is to be raised to a greater height than the machine, passes over a pulley fixed on the scaffolding. [WINDLASS.]

Crabro (Lat. *a hornet*). A genus of Hymenopterous insects, belonging to the section *Aculeata* or sting-bearers, and to the subsection *Fossores* or burrowers. The hornet (*Crabro vulgaris*) is the type of this genus, which is now raised to the rank of a family (*Crabronidæ*), including two groups of subgenera. In one of these groups all the species have their fore-legs provided with strong spurs, for the purpose of excavating in decayed wood, or burrowing in sand, in order to form cavities, in which their eggs are deposited; the insects of the other section have the fore-legs unarmed, and form no burrows, but deposit their eggs in the nests of other species. The true hornets (*Crabro*) excavate their retreat in wood, and feed their larvæ with the caterpillars of small moths found upon the oak, as well as with flies.

Cradling. In Architecture, the timber ribs in arched ceilings or coves to which the laths are nailed for the purpose of receiving the plastering are called *cradlings*, and generally any wood or iron substructure intended to receive an external coating is so called.

Craft. In Naval language, is a noun of multitude applied to any collection of decked vessels; but more commonly limited to small vessels.

Crag (Gael. creag, *a rock*). The name given to a part of the newer Tertiary formation in the east of England. It consists of a shelly sand and gravel used to fertilise soils where lime is wanting.

There is both a Norfolk crag and a Suffolk crag. The former is part of an accumulation of much newer date than the latter. It was made at the bottom of the sea, but at or near the mouth of a river. It is rich in shells, probably derived from the older crag, and also contains bones of the inhabitants of the adjacent land, among whom the elephant must be ranked. The red crag and coralline crag, the former being the uppermost, were certainly accumulated farther from land and in deeper water than the Norfolk crag. They consist chiefly of shells and corals, passing into a soft building stone. The combined thickness is rarely more than fifty or sixty feet, but both deposits are wonderfully rich in organic remains of all kinds.

Crambe (Gr. and Lat. *cabbage*). *C. maritima* is the wild British plant, which yields Sea-kale under the hands of the gardener. It is a genus of the *Cruciferæ* or cabbage tribe, found on our coast, and since its introduction to our gardens has furnished one of the most delicate of esculent vegetables, the parts used being the blanched leaf-stalks with more or less of the young stem, all in a succulent crisp condition.

Cramp. Spasmodic or involuntary contraction of some of the muscles, often attended with great pain; it is common in the muscles of the leg and foot, especially after any extraordinary exertion of them, and is sometimes brought on apparently by irritation in the stomach caused by indigestible food. When cramp seizes the calf of the leg, it usually goes off upon placing the limb in an erect posture and rubbing the affected part: persons subject to it find much relief by applying opiate liniments. If it arises from indigestion, or from indulgence in acescent drinks or champagne, mild bitters with magnesia taken at bedtime, will generally prevent its recurrence.

CRAMP. In Architecture, this term is applied to a piece of metal dovetailed, or let in at each end, for the purpose of holding two blocks of any material firmly together.

Crane. In Mechanics, a machine for raising heavy weights, and depositing them at some distance from their original place; for example, raising bales from the hold of a ship, and depositing them on the quay. A jib or transverse beam, inclined to the vertical at an angle of 40° or 50°, is constructed, which, by means of a collar, turns on a vertical arbor. The upper end of the jib carries a fixed pulley, and the lower end a cylinder, which is put in motion by a wheel and pinion, or cog-wheel, or merely with a handle. The weight is made fast to a rope which passes over the pulley and is wound round the cylinder. On turning the cylinder, the weight is raised as far as necessary; the jib is then turned on its arbor till the weight is brought immediately over the spot where it is to be deposited; when, by withdrawing the moving power, it is allowed to descend by its own gravity. Cranes may be constructed of immense power. They are generally turned by human force; sometimes, however, by a steam-engine.

Crane. In Ornithology. [GRUS.]

Crangon (Gr. κραγγών). The name of the genus of Macrourous Crustaceans, including the common shrimp (*Crangon vulgaris*, Fabr.). This species abounds most on sandy coasts, and is caught by means of a large open net fixed to the end of a long stick.

Craniology. [PHRENOLOGY.]

Cranium (Lat.; Gr. κρανίον). Sometimes applied to the entire bony compages of the head of the vertebrate animals; but, in Human Anatomy, is restricted to that portion of the skull which surrounds the brain.

Crank. A rigid arm fixed at one extremity on a shaft perpendicular to its own axis, and receiving at the other an alternative impulse which causes it to revolve in a circle. It is the most usual mode of converting alternative circular or rectilinear motions into continuous circular motion, or vice versâ; and for this purpose the crank requires to be connected with the prime mover by a chord or a rigid rod. In building operations, it is used to change the direction of the motion of bell-wires or other similar works.

CRANK (Ger. krank, *sick*). In Nautical language, a ship is said to be *crank*, when by the form of its construction, or by want of a sufficient quantity of ballast or cargo, or by being loaded too much above, it is incapable of carrying sail without being exposed to the danger of oversetting.

Crape (Fr. crêpe; Mr. Wedgwood connects the word with *crisp*). A species of gauze made of raw silk woven without crossing.

Crape Ring. [SATURN.]

Crassulaceæ (Crassula, one of the genera). A natural order of herbaceous or shrubby Exogens, of the Violal alliance, growing in hot, dry, and exposed situations. They are remarkable for the succulent nature of their stems and leaves, their many-leaved calyx, hypogynous petals, and their follicular apocarpous fruit. They have an affinity with *Saxifragaceæ* through *Penthorum*, and with *Illecebraceæ* through *Tillæa*; and possess refrigerant abstergent properties, mixed at times with a good deal of acridity.

Crater (Gr. *a mixing bowl*). The mouth of a VOLCANO [which see].

Crayons (Fr.). Coloured cylinders used for drawing upon paper; they are usually made of a fine pipe-clay, coloured with metallic pigments or carmine. Crayons containing plumbago are styled *solid lead pencils*.

Cream (Fr. crême). A semifluid yellowish substance which collects on the surface of milk, and which is made into butter by the process of churning. When the milk of any animal is allowed to stand for some time, it spontaneously undergoes certain changes; the cream rises to the surface, and forms a thin stratum, which consists chiefly of oily globules; while the milk below, which of course is thinner than it was before the cream separated from it, is of a pale bluish colour, and consists of a solution of the curd, or caseum, in the whey. When cream is kept for some days, it gradually becomes thicker and partially coagulated; and if put into a linen bag and suspended in a cool room, it will acquire the consistence of soft cheese; and this is one among other modes of making cream-cheese. When cream is churned, it is resolved into butter and buttermilk. In order to make butter, it is not always necessary that the cream should be separated from the milk; but whether separated or not, the process is facilitated by allowing the liquid to stand for some time, during which a part of the sugar contained in the serum, or whey, is changed into an acid, which shortens the process of churning by facilitating the separation of the butter from the milk. When either cream or milk is churned without having previously become slightly sour, the process is more tedious; and sometimes, from causes not easily accounted for by the dairymaid, it is unsuccessful, and the milk is said to be *bewitched*. The true cause, however, is the want of acidity; because it has been found that the addition of a very small portion of vinegar will dissolve the charm, and cause the almost immediate appearance of butter. Cream, when separated from milk and kept till it has become acid, is frequently eaten with sugar, and is one of the most delicious preparations of the dairy. Costorphine cream, so called from a village of that name in the neighbourhood of Edinburgh, is made by putting the milk of three or four days together with the cream into a vessel, and allowing it to remain there till it has become sour and coagulated. The whey is then drawn off, and fresh cream added; and when it is brought to table it is eaten with sugar, and in the strawberry season with that fruit. Devonshire cream is simply sour curd, or sour cream, mixed with fresh milk, or fresh cream, and eaten with or without sugar. Devonshire scalded or clouted cream is milk and cream heated to the boiling point, and suffered to cool, when the cream will be found to have separated from the milk, and when skimmed off may either be made into butter or eaten with fresh cream and sugar. Common clotted cream is simply milk and cream in a coagulated state, and sour. When the clotted cream is broken and stirred, and the whey drawn off, the mass may be turned into cheese by artificial pressure, or by suspending it in a porous bag, in a cool airy situation. [BUTTER; CHEESE.]

Creasote. [KREASOTE.]

Creatine. [KREATINE.]

Credence Table. In Ecclesiastical Architecture, this term is applied to a table put near one side of the altar to receive the utensils required for the ministration of the Holy Communion.

Credentials, Letters of. The instrument in the form of a letter, from one monarch to another, which constitutes the evidence of the title of a minister at a foreign court to the power which he exercises. There are two sorts

of credentials: the one sealed, drawn up and countersigned by the minister of foreign affairs; the other open, signed only by the king. Unless the minister be mentioned expressly in his credentials as an ambassador, he has a right only to the observances due to foreign ministers of inferior rank.

Credit (from Lat. credo, *I give credit to*). In Political Economy, this term is used to express the lending of wealth, or of the means of acquiring wealth, by one individual or set of individuals to another. The party who lends is said to give credit, and the party who borrows to obtain credit. Hence credit may be defined to be the acquisition by one party of the wealth of another in loan, according to conditions voluntarily agreed on between them.

Very exaggerated notions are commonly entertained of the influences of credit; but, in fact, all operations in which credit is given or acquired resolve themselves into a new distribution of wealth already in existence. The *magical* effect that is every now and then ascribed to credit is due to the fact that by the confidence implied in the giving credit, capital heretofore dormant or imperfectly productive becomes active or productive. A party who purchases goods payable at some future date obviously acquires the command of so much of the capital of the seller of the goods as their value amounts to, in the same way that a party who discounts a bill acquires the command of a corresponding portion of the capital of the discounter. Wealth is not created by the issue of bills; and all that their negotiation does is to transfer already existing property from one individual or party to another; or, to exhibit the fact in a still more simple form, the credit given by A to B is an asset of A and a liability of B. To confound credit with wealth, is to confound the economical organisation of society with society itself.

In the great majority of cases loans are made by individuals who wish to retire from business, or who have more capital than they can advantageously employ, to individuals entering into business, or who wish to extend their concerns and to acquire a greater command of capital. The probability is, that capital will be more likely to be efficiently employed by the latter than by the former class of persons; and the advantage of credit, in a national point of view, consists in that circumstance. Loans made to prodigals or spendthrifts, or to individuals who expend them on unprofitable undertakings, are, in so far, publicly injurious; but, speaking generally, these bear but a very small proportion to the other class of loans, or those made to individuals by whom they are advantageously expended.

Public credit is the phrase used to express the trust or confidence placed in the state by those who lend money to government.

The interest or premium paid by the borrowers to the lenders depends on a great variety of circumstances—partly on the rate of profit that may be made by the employment of capital at the time, partly on the duration of the loan and the security for its repayment, and partly on the facilities given by the law for enforcing payment. The only way, indeed, in which a government can advantageously interfere to encourage credit is by simplifying the administration of the law, and by giving every facility for carrying the conditions of contracts into effect.

Crédit Foncier. This is an expedient by which, at different periods and places, sums needed for the improvement of estates have been raised for specified periods, the security being at once on the particular estate of the borrower and the joint guarantee of the subscribers to the association. Ordinarily, a sinking fund has been created simultaneously with the loan. Illustrations of this scheme may be found in our own country, in the powers given to boards of guardians and local commissioners of borrowing sums upon the security of rates; the sums to be repaid by instalments at definite periods, and to bear a fixed rate of interest during the term. The system has been extended in France, by giving powers to joint-stock companies to act as intermediaries in such transactions, the profits of the society being derived from a percentage charged for their superintendence and guarantee. In England these functions are generally performed by insurance companies, who, being able by the very circumstances of their existence to make loans for considerable periods on the stipulation of the gradual repayment of the principal, are enabled to fulfil some very important functions in operations of great public utility or necessity.

As long as the obligations created by these transactions are not transferable, except in the ordinary way of notice and registration, the effect of the Crédit Foncier is, on the general hypothesis of prudence in advances, of great public benefit. Sometimes, however, the securities created have been treated as susceptible of simple assignment or transfer without endorsement, and have thus been employed as a form of currency, and circulated as likely to be popular in consequence of the accruing interest implied in their possession. From such a theory it is but a short step to attempt a compulsory paper currency, based, or supposed to be based, on other commodities than gold and silver. It is almost needless to say that this theory always involves the most fatal consequences, and that experience from the time of Law's scheme onwards has always demonstrated the madness of attempting any circulation which is not based on the precious metals. (Tooke's *History of Prices*, vol. vi. pp. 96 sqq.)

Crédit Mobilier. This is a name given to a gigantic scheme promulgated in France in 1852, and sanctioned by the existing government, the objects of which are: 1. To take in hand and originate trading enterprises of all kinds on the principle of limited liability. 2. To supersede

or buy up trading companies, e.g. railway companies, and to substitute scrip and shares of its own, and in its own name, for the shares and bonds of the company; and 3. To carry on, on the limited liability principle, the business of a bank or bankers and a stock jobber.

It will be manifest that schemes so vast as these contain in them elements of considerable commercial risk, and are singularly provocative of wild and injudicious speculation. The reader will find the plan severely criticised by Mr. Tooke (*History of Prices*); and certainly no words are too strong, if we look at such an association from the point of view taken by English practice, and by the light afforded by past experience, to stigmatise so rash and dangerous an accumulation of purposes. But it must be borne in mind that France, from the character of its political and social organisation, is at once singularly disposed to such expedients and very capable of accommodation to them. The people are familiar with government superintendence, and the undertakings in question are supplied, as a rule, by small contributions of capital. During the past year (1864), financial schemes analogous to those above named have been started in England, and at present have found favour with the public. But the circumstances of the period referred to have been so exceptional, and the high rate of interest has caused so great an activity in all departments of the money market, that, while we can very well account for the disposition to enter into schemes analogous to those described above, it would be wholly premature to venture any prediction as to their ultimate success. Of one thing we may be quite sure, that any plan which seems to create negotiable securities for long terms, or which bases its operations on obligations which are not readily convertible, is, judging by the past, unsafe and unwise, and wholly unlike in character all those undertakings which have hitherto been successful.

Creditor. [BANKRUPTCY.]

Creed. Any brief summary of Christian belief; but more especially either of the three confessions commonly called the Apostles', Nicene, and Athanasian. The term is derived from the Latin credo, *I believe*; in like manner as Paternoster, Avemaria, &c., are prayers named from the first words of these formulas in the Latin tongue.

Creek (A.-Sax. crecca, Fr. crique). A shore or bank on which the water beats, running in a small channel from any part of the sea. It is also applied to any part of a large river which is resorted to as a harbour or landing place by small craft. In the United States, the term *creek* is used as synonymous with our English word *brook* or *rivulet*.

Creel. A kind of basket; as, for instance, the baskets used by anglers.

Cremation (Lat. crematio). In Antiquities, a word particularly used to designate the ancient practice of burning the dead.

Cremocarp (a word made up from Gr. κρεμάννυμι, *I suspend*, and καρπός, *fruit*). A two to five celled inferior fruit, the cells of which are one-seeded, indehiscent, dry, perfectly close at all times, and when ripe hanging separate from a common axis, as in umbelliferous plants.

Cremona. A general designation of the violins made at Cremona in Italy, during the seventeenth and eighteenth centuries, chiefly by the family Amati. [VIOLIN.] Cremona is also a name erroneously given to a stop in the organ; being nothing more than a corruption of *krumhorn*, an ancient wind instrument, which it was originally designed to imitate.

Crenel (Fr. creneau, *battlement*). A word employed in Gothic military architecture to express the battlements of a castle, or other building, which are so broken as to provide shelter for a man with a bow and arrow, or some other weapon of offence. During the latter part of the middle ages, crenellated parapets were introduced into buildings of all kinds.

Crenic Acid or **Krenic Acid** (Gr. κρήνη, *a fountain*). A term applied by Berzelius to a species of extractive matter occurring in spring-water.

Creole (Span. criollo). A name given to the descendants of whites born in Mexico, South America, and the West Indies; in whom the European blood has been mixed with that of other races. The various jargons spoken in the West India islands by slaves, &c., are called *Creole dialects*.

Crepitus (Lat.). The crackling noise which is produced upon pressing cellular membrane when it contains air.

Crescendo (Ital.). In Music, a direction to the performer to increase the loudness of the sound; marked thus <.

Crescent (Lat. cresco, *I increase*). In Heraldry, a bearing in form of a young moon. When the horns are turned towards the chief or upper part of the shield, it is called *crescent*, in contradistinction to the terms *increscent* and *decrescent*; in the former of which the horns are turned to the right, and in the latter to the left side of the shield. The crescent is frequently used to distinguish the coat armour of a second brother or junior family from that of the principal branch. As is well known, the crescent, or, as it is usually designated, the *crescent montant*, has become the symbol of the Turkish Empire, which has thence been frequently styled the Empire of the Crescent. This symbol, however, did not originate with the Turks. Long before their conquest of Constantinople the crescent had been used as emblematic of sovereignty, as may be seen from the still existing medals struck in honour of Augustus, Trajan, and others, and it had always been the symbol of Byzantium. On the overthrow of this empire by Mohammed II., the Turks, regarding the crescent which everywhere met their eye as a good omen, adopted it as their chief bearing; and it has continued ever since to decorate their minarets, their insignia, their dress, and in

short everything appertaining to their empire. Crescent has also been applied to three orders of knighthood, the first of which was instituted by Charles I., king of Naples and Sicily, in 1268; the second by Rene of Anjou, in 1448; and the third by the Sultan Selim in 1801, two years after the battle of Aboukir. The last-mentioned order is still in existence, and is remarkable for the fact that none but Christians are eligible for admission.

Crescentiaceæ (Crescentia, one of the genera). An order of Bignonial Exogens, allied to *Bignoniaceæ*, but differing in their one-celled ovary with parietal placentæ, and in their large succulent fruit with almond-like wingless seeds. They form trees, and abound in the tropics of Asia, Africa, and America. *Crescentia Cujute*, the Calabash-tree, grows thirty feet high, and the hard woody shell of its fruit serves for various domestic uses.

Crest (Lat. crista). In Architecture, a term applied to a running ornament in a horizontal direction above the line of the cornice, as on the ridge of a roof, a canopy, or any similar works.

CREST (Lat.). In Heraldry, the ornament affixed to the helmet, being a personal or hereditary device. Warriors bore insignia peculiar to themselves in this manner among the classical ancients. The earliest instance of the heraldic crest in England is said to be that of Edmund Crouchback, earl of Lancaster (about 1280). The crest is, in modern blazonry, a figure placed upon a wreath, coronet, or cap of maintenance, which surmounts the coat of arms. It is not unfrequently a repetition of some bearing in the shield itself; as, the crest of Castile is a castle.

Cretaceous System (Lat. creta, *chalk*). The newest of the secondary or mesozoic series of rocks, underlying the tertiaries and resting on the Wealden or oolitic rocks. It is subdivided in England into CHALK and GREENSAND, but elsewhere the representatives are very varied. Limestones represent the upper and sandstones the lower portion of the system, and the whole may be regarded as highly fossiliferous, though with many barren places. [CHALK; GAULT; UPPER GREENSAND and LOWER GREENSAND.]

Crétins. A name applied in the Valais and elsewhere to a class of idiots, who are also generally afflicted with GOITRES [which see].

Crew of a Ship. Comprises all the officers and men, combatant and non-combatant. In a large vessel the word *crew* is also applied to several smaller sections of men, as the carpenter's crew, sailmaker's crew, &c., signifying respectively the carpenter and sailmaker with their several subordinates.

Crib (Dutch, kribbe; Ger. krippe). Sometimes applied to a rack for hay or straw for cattle, and sometimes to a manger for corn or chaff; also to a small enclosure in a cow-house or shed for calves or sheep.

Crib-biting. Biting the manger or crib; a bad habit among horses, brought on by uneasiness occasioned by diseases of the teeth, or by roughness in the person who currycombs them.

Cribbage. A very popular game at cards for two persons. Five cards are dealt to each, when each player casts out two, to form what is called the *crib*, of four cards, which belongs to the dealer. The elder hand then cuts the pack, and the dealer turns up a card, which is called the *turn-up*, and is considered in scoring (as hereafter explained) to belong to both hands as well as to the crib. The parties then play out, alternately, the cards in their hands, beginning with the elder hand, and counting the pips (every court card counts ten) up to 31, beyond which the play is not carried. The game is 61 points, which are scored with pegs on a board called a *cribbage-board*, having 61 holes on each side. Points are made as follows: (1.) Any combination of cards in hands or crib (including always the turn-up in both) the united pips of which make up 15, scores 2 points, and if the hand contain also a duplicate of any one card of the combination, the 15 is counted twice over. (2.) A sequence in rank (without reference to suit) of three or more cards scores 1 for each card, and is scored twice if there be also a duplicate of one of the cards. (3.) Two similar cards of different suits (as two fours, two kings, &c.), form a pair, and score 2. Three form a *pair-royal*, scoring 6, and four a *double pair-royal*, scoring 12. *Example*: Two sevens, an eight, and a nine in crib, with an eight turned up, would score 24, i.e. 4 fifteens=8, 4 sequences of 3=12, and 2 pairs=4. (4.) If the three cards in either hand, or the five cards in crib and turn-up are all of the same suit, it is called a *flush* and scores one for each card. (5.) When the turn-up is a knave, the dealer scores 2; and if there be a knave of the same suit as the turn-up in either hand or the crib, the holder scores 1. (6.) In playing the hands, any fifteens, pairs, or sequences made by cards consecutively played score for the person who plays the last card of them. The last card of the play, if it counts 31, scores 2; if under 31, it scores 1. The elder hand at the beginning of the game scores 3. Cribbage is sometimes played with six cards, but this does not make so good a game.

Cribble. A coarse sieve, or screen, for sifting sand, gravel, or corn; the term is also applied to a sort of coarse meal.

Crichtonite. A variety of Titaniferous Iron, found in Dauphiné, and named after Dr. Crichton.

Cricket. A well-known game played with bat and ball. The word is perhaps derived from the Anglo-Saxon creag, *a crooked stick*: but, although the game itself seems to have been known in the thirteenth century, no reference is found to it under its present name till towards the close of the seventeenth. The south and south-eastern counties of England took up the game with the greatest ardour; and the parish of Farnham, in Surrey, was

especially celebrated for the skill of its players towards the end of the last century, when the game was slowly acquiring general popularity. More recently the taste for this manly game has been widely spread throughout England and the southern parts of Scotland, although it has not yet made itself popular in any other country. In both the games of cricket, called *double-wicket* and *single-wicket*, the victory is won by that side which obtains the greatest number of runs in two innings. The laws of the game were revised by the Marylebone Club in 1844.

CRICKET. In Entomology. [GRYLLUS.]

Cricoid (Gr. κρικοειδής). Annular or ring-shaped. A cartilage of the larynx is hence called the *cricoid cartilage*.

Crime. [LAW, CRIMINAL.]

Cringles. On Shipboard, loops formed in the bolt-ropes of the sails by intertwisting the strands composing the ropes. The object is to enable the bolt-ropes to be gathered up by a rope passed through them.

Crino. A cuticular disease, supposed to arise from the insinuation of a *hair-worm* under the skin of infants.

Crinoideans, Crinoidea (Gr. κρίνον, *a lily*, and εἶδος, *appearance*). A name given by Miller to an extinct family of Echinoderms, having a radiated, lily-shaped disc, supported on a jointed stem. When this stem is cylindrical, the species are termed ENCRINITES; when it is pentagonal, PENTACRINITES [see these words].

Crisis (Gr. *a judging*). In Medicine, certain symptoms which announce a favourable or an unfavourable termination of a disease are called *critical symptoms*, and the period at which they show themselves the *crisis* of the disease. In the progress of fevers these symptoms have been supposed to show themselves at certain definite periods, which therefore have been called *critical days*.

Crithmum (Gr. κριθή, *barley*, from the resemblance of the fruits). An umbelliferous plant, found on our rocky coasts. It yields Samphire, which consists of the young leaves of *C. maritimum*, and is valued as a pickle.

Critical Philosophy. The metaphysical system of Kant is sometimes so termed, from his famous work, the *Kritik der Reinen Vernunft* (Critic of Pure Reason). [KANTIAN PHILOSOPHY.]

Criticism (Gr. κριτικός, from κρίνω, *I judge*). Has been defined 'the art of judging with propriety concerning any object, or combination of objects.' In a somewhat more limited, but still extensive meaning, its province is confined to literature, philology, and the fine arts; and to subjects of antiquarian, scientific, or historical investigation. In this sense, every branch of literary study, as well as each of the fine arts, has its proper criticism as an appendage to it. The elements of criticism depend on the two principles of Beauty and Truth, one of which is the final end or object of study in every one of its pursuits: Beauty, in letters and the arts; Truth, in history and the sciences. The office of criticism, therefore, is, first to lay down those forms or essential ideas which answer to our conception of the beautiful or the true in each branch of study; and, next, to point out by reference to those ideas the excellences or defects of individual works, as they approach or diverge from the requisite standard in each particular. Thus, historical criticism teaches us to distinguish the true from the false, or the probable from the improbable, in historical works; scientific criticism has the same object in each respective line of science; while literary criticism, in a general sense, has for its principal employment the investigation of the merits and demerits of style or diction, according to the received standard of excellence in every language; and, in poetry and the arts, criticism developes the principles of that more refined and exquisite sense of beauty which forms the ideal model of perfection in each. [BELLES-LETTRES and RHETORIC.]

Criticism, in a more limited sense, is a branch of belles-lettres. Essays written for the purpose of commending or censuring works in literature or the arts, and pointing out their various merits and defects, are works in the critical department. Thus the term *periodical criticism* is used to express the body of writing contained in the various works under the name of magazines, reviews, &c., which are periodically published in most literary countries.

Crocidolite (Gr. κροκίς or κροκύς, *a woof*, and λίθος, *stone*). A hydrated silicate of protoxide of iron, soda and magnesia: found in South Africa in the Griqua country beyond the Great Orange River, and in the micaceous porphyry of Wakenbach in the Vosges.

Crockets. In Gothic Architecture, ornaments resembling curved and bent foliage running up on the edge of a gable or a pinnacle. They are of two varieties; the earliest are formed by simple curves turning downwards, as in the gables and spires of Lincoln Minster; the latter having the point of the leaves returned and pointing upwards. Sometimes animals are substituted in place of the leaves in the later examples, about the time of the Renaissance.

Crocodile (Gr. κροκόδειλος). A name first applied by Herodotus to the crocodile of Egypt, because that animal resembled a small lizard of the same name (*Stellio* of the moderns), which is now known in Greece under the name of *Koslordylus*. The Egyptian and other species of crocodile were confounded by Linnæus under the name of *Lacerta Crocodilus*; but the crocodiles are distinguished from all Saurian reptiles, or *Lacertilia*, by the following characters: They have a long and powerful tail, which is flattened in the vertical direction, to serve as the principal means of propelling the body through water with the swiftness required in the pursuit of fish, which form the principal prey of the crocodile. The extremities are short, and comparatively of little use in aquatic

progression, except in guiding and changing the direction of the motion, for which purpose they are always webbed or half-webbed. The fleshy tongue is attached by its entire marginal circumference, as in most fishes, to the inner side of the lower jaw, and is not extensible, as is the case in all true lizards. The teeth are simple, conical, sharp-pointed, large, lodged in distinct sockets, and arranged in a single row; which structure and disposition are in relation with the carnivorous habits of the crocodile. Lastly, the intromittent organ of the male is single.

To these essential differences between the crocodiles and lizards may be added the following characters, which are common to all the crocodiles:—

1. The fore-feet have five toes; the hind-feet four toes.

2. Three toes only on each foot are armed with claws; so that there are two toes in front and one behind which have no claws.

3. The whole of the tail and the upper and under parts of the body are covered with square scutæ or plate-scales; and the greater number of those on the back are traversed longitudinally by a more or less prominent ridge.

4. The sides of the body are covered with small round scales.

5. The ridges on the scales of the tail form at its base two prominent lateral series, or dentated keel-like crests, which converge and blend into one at the posterior part of the tail.

6. The tympanum or drum of the ear is protected by two movable flaps.

7. The eyes are provided with three eyelids.

8. Two little pouches containing a substance of a musky odour.

Their anatomy also affords some characters which are common to all the species, and very well distinguish their skeleton from that of other Saurians. The ventricles of the heart do not intercommunicate. The vertebræ in the cervical region support a series of spurious ribs, which are directed backwards, and the extremities of each overlapping the next in succession prevent the animal from turning the head to the side. This structure, it will be seen, is in admirable accordance with the aquatic habits of these large piscivorous reptiles; since, in order to displace the fluid medium through which they move, it is essential that the head should be firmly locked to the trunk. It is for this reason that the vertebræ immediately behind the head in fishes bear ribs; and the cervical vertebræ of the whale, although they accord in their number and in the absence of ribs with those of other mammalia, are modified so as to answer the same end as the costo-cervical vertebræ of crocodiles and fishes, being compressed from before backwards, and anchylosed sometimes into a single piece.

Croconic Acid (Gr. *κρόκος*, *saffron*). A yellow substance resulting from the action of potassium on carbonic oxide. It is not easily soluble, and has a sour astringent taste.

Crocus (Lat.; Gr. *κρόκος*). A familiar genus of *Iridaceæ*, yielding some of our most beautiful spring flowers, and furnishing also the Saffron of commerce, which consists of the deep orange-coloured stigmas of *C. sativus* gathered with part of the style, and carefully dried.

Croft (A.-Sax.). A small field adjoining the dwelling-house and kitchen garden. The term is also sometimes applied to common field lands. An *undercroft* sometimes signifies a crypt.

Cromfordite or **Horn Lead.** Chloro-carbonate of lead. This rare mineral was originally obtained from a mine near Cromford in Derbyshire; but it has, also, been met with in Cornwall, at Elgin in Scotland, and on the volcanic sand of Vesuvius.

Cromlechs. In British Antiquities, the term *cromlech* is applied to large flat stones laid across others fixed vertically in the ground, which are found in parts of Wales, in Devonshire, Cornwall, and some other districts in England; in Brittany, Denmark, Germany, and some other parts of Europe. Cromlechs have usually been supposed to have served as altars, but their first purpose was to serve as places of burial. (Worsae, *Scandinavian Antiquities*.)

Cronstedite. A hydrated silicate of iron named after Cronstedt, the Swedish mineralogist.

Crops, Rotation of. [AGRICULTURE.]

Croquet. A game recently introduced into this country, and played with balls and clubs, the object of the game being to propel a ball through a number of hoops fastened into the ground, to a fixed goal, and thence back to the starting point. The laws of the game have been explained in a treatise by M. Jaques.

Crosier. The staff of an archbishop, surmounted by a cross (whence its name), and thereby distinguished from the pastoral staff or crook of a bishop.

Cross (Lat. crux). A gibbet made of two pieces of wood laid upon each other at any angle. Originally, it was nothing more than a tree; but it afterwards assumed a variety of forms, of which the following are the most usual examples: × ⊤ ✝. The cross was used as a very general instrument of punishment from the earliest times. Among the Syrians, Jews, Egyptians, Persians, and especially the Carthaginians, it appears to have been the usual military punishment. (Val. Max. ii. 7; Herod. iii. 125–159.) But in no part of the ancient world was this punishment so generally resorted to as in the Roman empire, where it was regarded as the most infamous of deaths, and, except in cases of sedition, was inflicted only on slaves or the vilest malefactors. By the Roman law, the culprit was scourged previously to the crucifixion, either in the prætorium or on the way to the place of execution. On his arrival there he was stripped of his garments, and then either nailed by the hands and feet to the cross, or, as sometimes happened, only fastened to it by ropes. In order to hasten death, it was the practice to

break the legs or to pierce the body of the sufferer with a spear or other sharp instrument; but this was not always done; and instances have occurred of persons who, after being suspended for some considerable time on the cross, were taken down and survived. By the Jewish law, it was ordained, that the body of the culprit should be removed from the cross on the day of his execution; but the Romans frequently allowed it to hang till it dropped piecemeal to the ground. In general, the cross was erected near some great road or highway, in order to indicate more distinctly the ignominy of the culprit and the severity of his death.

By the death of Christ, the cross, from being an object of horror, became the symbol of the Christian world, and in the end came to be regarded even with superstitious veneration. Constantine, from respect for these feelings, abolished the punishment of crucifixion throughout the Roman world.

In the Romish church certain festivals are observed in memory of circumstances connected with the cross; as the Invention or Discovery and the Exaltation of the Cross: the former commemorates the supposed discovery of the true cross by the Empress Helena, the latter its restoration to Calvary by Heraclius.

CROSS, GREEK AND LATIN. The cross on which our Lord suffered is commonly considered to have been the *crux capitata* with the lower limb longer than the others, ✝. But the cross with equal limbs, commonly termed the *Greek cross*, has been the model followed in the architecture of Eastern churches, and would have been followed in St. Peter's at Rome had the original plan of Michael Angelo been executed.

CROSS. In Heraldry, an ordinary, formed by lines drawn palewise and fesswise, enclosing (if bounded by the escutcheon) one-fifth of the shield, or one-third if charged. A cross gules is termed *the cross of St. George*. A plain cross is one of which the extremities do not reach to the circumference of the escutcheon, but are *couped*, or cut off in a straight line. There are many other kinds of crosses, not reaching the circumference of the escutcheon, known in heraldry; the following are only a few, most commonly used in bearings: A *cross crosslet* is one crossed on each arm. Such a cross between four plain crosses is termed *a Jerusalem cross*. A *cross flory* has three points at each end. A *Maltese cross* has arms increasing in breadth towards the end, with double points. A *cross fitchy* has the lower limb pointed, as if to fix in the ground. A *patriarchal cross*, the insignia of patriarchs or archbishops, is plain, having two bars, the upper smaller than the lower. A *cross moline* terminates in representations of the ends of the fer-de-moulin, or milrind. It is the difference of the eighth son of a family.

CROSS. An instrument formerly used in surveying for laying out perpendicular lines, but now seldom employed. It consists of a brass cross or circle, divided into four equal parts by two diameters at right angles to each other. At each extremity of these diameters perpendicular sights are fixed. The instrument is mounted on a staff to fix it in the ground, and its use is to find, in a given line, the foot of the perpendicular let fall thereon from an object at some distance.

Crosses, Stone. In Architectural Antiquities, are of various kinds, according to the occasion or purpose of their erection. They are said to have originated in the practice of marking the Druidical stones with a cross at the period of the conversion of the Celtic tribes to Christianity. *Preaching crosses* are generally quadrangular or hexagonal, open on one or both sides, and raised on steps; they were used for the delivery of sermons in the open air: the celebrated Paul's Cross was an instance of this application. *Market crosses* are well known, from the examples of Winchester, Chichester, Aberdeen, Malmesbury, &c. *Weeping crosses* were so called because penances were finished before them. *Crosses of memorial* were raised on various occasions; sometimes where the bier of an eminent person had stopped on its way to the place of burial, sometimes in attestation of a miracle performed on the spot: the crosses erected at the resting-places of Queen Philippa's bier may be cited as illustrations of this variety. Crosses served also as landmarks; they were originally used for this purpose by the Templars and Hospitallers of St. John of Jerusalem.

Cross Flookans. A name applied by the miners of Cornwall to veins of stony matter running north and south.

Cross Jack Yard. In Navigation, the lower yard in the mizen-mast.

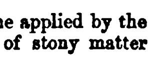
Cross-bow. A weapon used for shooting with, before the invention of firearms. All weapons having the bow attached to a stock were called cross-bows; and some of the larger sort were furnished with instruments for bending the bow. [ARBALEST.]

Cross-breed. The offspring of parents of two different breeds.

Cross-furrow. A furrow or open trench cut across other furrows to intercept the water which runs along them, in order to convey it to the margin of the field, where it may find its way to an open ditch or some other general drain.

Cross-stone. A mineralogical synonym for Staurolite. The name has also been applied to Harmotome in consequence of the intersection of the crystals, which often cross each other at right angles and lengthwise, so that their axes coincide. [ANDREASBERGOLITE and HARMOTOME.]

Crossettes (Fr.). In Architecture, the returns on the corners of door cases or window frames; called also *ears*, *elbows*, *ancones*, *prothyrides*. In architectural construction, they are the small projecting pieces in arch stones which hang upon the adjacent stones—*a*, *a*, *a*, *a*.



Crotalaria (Gr. κρόταλον, *a rattle*). A very extensive genus of tropical herbs or shrubs of the order *Leguminosæ*, the most important of which is *C. juncea*, the Sunn Hemp of India, a plant extensively cultivated for its fibre, which is considered equal if not superior to Russian hemp.

Crotalum (Gr. κρόταλον). An ancient kind of castanet, used by the Corybantes or priests of Cybele. This instrument must not be confounded with the modern *crotalo*, a musical instrument used chiefly by the Turks, and corresponding exactly with the ancient cymbalum.

Crotalus (Gr. κρόταλον). A genus of poisonous serpents, including those which are furnished with a rattle at the extremity of the tail.

Crotchet. In Music, one of the notes or characters of time, equal to half a minim.

Crotchets. In Grammar, more frequently called *brackets*, are certain marks or hooks in which words or phrases are included thus [ ], by way of distinguishing them from or of illustrating the context.

Croton (Gr.). An important genus of *Euphorbiaceæ*, consisting of herbs or trees with monœcious flowers having a five-parted calyx, the five-petaled males with ten stamens, and the apetalous females with three styles. *C. Tiglium* is a medicinal Indian species, the purgative seeds of which yield an acrid oil. *C. Eleutheria* of the West Indies is the source of the aromatic Cascarilla bark. *C. lacciferum* in Ceylon and *C. Draco* in Mexico furnish resins used in making varnish.

Croton Oil. The expressed oil of the seeds of the *Croton Tiglium*; formerly called *Grana Tiglia*, and *Molucca grains*. The tree is a native of Ceylon, and of Malabar and the Molucca Islands. Its seeds are very purgative; and their expressed oil so drastic, that a single drop will often prove violently operative, completely emptying the bowels and exciting a copious watery secretion from them. The most active form for its exhibition is made into a pill with bread crumb: it may also be rubbed with a little mucilage of gum arabic, and given in a liquid form; but it always requires much caution in its administration.

Croup. An inflammation of the larynx and trachea, accompanied by difficulty of breathing and cough, and by a peculiar shrillness of voice and wheezing; there is also generally more or less expectoration of purulent and filmy matter, which is thrown out upon the affected part and continually threatens suffocation. This disease is most common in infants, and in children from three to nine years old; it is of rare occurrence, in its acute form at least, after twelve years of age. In the successful treatment of this distressing and dangerous disease, everything depends upon promptitude in the application of remedies calculated to subdue the local inflammatory action. This is to be done either by leeches to the region of the trachea, by cupping, or by bleeding in the jugular vein; by the cautious application of external irritants of rapid action, such as a piece of lint dipped in strong acetic acid, which, however painful, is sometimes of service; by blisters, and by the exhibition of large doses of calomel: there is a difference of opinion as to the employment of emetics. The inhalation of steam is useful where it can be resorted to, but in young children it is impracticable. In *spasmodic croup* the wheezing and sense of suffocation appear to depend upon spasmodic action of the larynx or epiglottis: like the former, it attacks infants and children, but comes on and goes off very suddenly, returning at intervals, during which the patient is comparatively easy. In weakly and irritable children it sometimes appears to be a consequence of teething. An emetic, calomel purges, warm bath, diaphoretics, and a blister, are the leading remedies; bleeding should be avoided. There is a kind of croup which sometimes attacks children of weakly constitutions, and which appears symptomatic of irritation in the stomach and bowels, for it is relieved by purging, and disappears as the constitution improves. Another form of this disease is called *chronic croup*. It is attended by cough and the expectoration of tough mucus, sometimes apparently membranous or tubular, occasioning difficulty of breathing and suffocation. This disordered state of the trachea and bronchial membranes may occur at all periods of life: it is relieved, and often cured, by using the inhaler with warm water, by expectorants with small doses of sedatives and mercurials, and by occasional purging.

Crow Coal. A kind of coal almost without bitumen, which is found at Alston Moor in Cumberland.

Crow's Feet. Iron-pointed stars, or nails so radiating, that however thrown on the ground, they will always have a point uppermost. They are used as obstacles to the approach of an enemy, and are especially useful against cavalry.

Crown (Lat. corona). In Architecture, the uppermost member of a cornice; called also the *corona* or the *larmier*.

CROWN. In Heraldry. Among the ancients, and especially in the Roman republic, crowns were presented to citizens as marks of distinction for valiant or otherwise meritorious exploits. From this usage the crown has been adopted as a bearing by modern heralds. Nine species of the crown are enumerated in heraldry; some of which, however, have not been introduced into modern arms, and are only known from the description left of them by the ancients: 1. The Eastern Crown, imitated from that which appears on coins of Greek oriental sovereigns, and borne by those who have distinguished themselves in the East; the East India Company's arms have this crown. 2. The Triumphal Crown, which, after being borne by Julius Cæsar, became the Crown Imperial. 3. The plain Circlet or Diadem. 4. The Obsidional Crown, given

among the Romans to those who had performed exploits in the defence of fortified places. 5. The Civic Crown, for saving the life of a citizen. 6. The Crown Vallary, to soldiers who had first entered the enemy's trench. 7. The Mural Crown, to soldiers distinguished in besieging armies. 8. The Naval Crown, common in English coats of augmentation. 9. The Crown Celestial.

Crown Glass. The glass usually employed for windows. It differs from *flint glass* in containing no oxide of lead, and is made of a mixture of 100 parts of sand, 35 of soda-ash or potash, and 35 of chalk. It is, therefore, essentially a silicate of soda, or potash, and lime. [GLASS.]

Crown or Demesne Lands (Low Lat. *Terræ Dominicales*). The lands, estates, or other real property belonging to the crown or sovereign. These were anciently very extensive. The rents and other payments arising from them formed in the middle ages an important part of the revenue of our English kings; and they still form an important part of the revenue of several Continental sovereigns. These lands have been acquired by various means, such as purchase, succession, forfeiture, &c. Having been regarded for a lengthened period as the private property of the crown, and as being consequently at the free disposal of the sovereign for the time being, little providence has been displayed in their management. A grant of crown lands was, indeed, the ordinary method in which our sovereigns used formerly to gratify their favourites; and, in consequence of the magnitude and improvidence of such grants, the crown estates in this country have been reduced within very narrow limits. Parliament frequently interposed to check this profusion, but without effect till after the Revolution, when the lavish grants of crown lands, made by William III. to the Bentinck and other families, occasioned so much dissatisfaction that the practice was put an end to. This was done by the Act 1 Anne st. 1, cap. 7, which declared that all future grants or leases of land from the crown for a longer term than thirty-one years, and of houses for a longer term than fifty years, should be void.

The crown estates, forests, manorial rights, &c., not granted away, have now become, in consequence of arrangements to that effect, the property of the public; and are administered by a department specially appropriated to that purpose, called that of the 'Commissioners of Woods and Forests.' Their total nett revenue in 1863 amounted to about 432,000*l.*, the expenditure being 157,000*l.* Of late years a considerable extent of crown lands, consisting of old forests and chaces, has been enclosed and planted with forest trees, with a view to the supply of timber for the navy.

Crozophora. A genus of *Euphorbiaceæ* yielding the dye called *Turnsole*, which is obtained by grinding *C. tinctoria* to a pulp; this yields half its weight of dark green juice, becoming purple by exposure. The herb grows wild in the countries bordering the Mediterranean, and is cultivated in the South of France.

Crucible (Lat. crucio, *I torment*; because, in the language of old chemistry, the metals were tortured by fire to yield up their various virtues). A vessel, generally made of very refractory earthenware, in constant use in the chemical laboratory for performing fusions of metals and other substances.

Cruciferæ (Lat. *cross-bearers*; the flowers being in the form of a Maltese cross). A natural order of Cistal Exogens, inhabiting most of the temperate countries. They are allied to *Capparidaceæ*, but differ in their tetradynamous stamens; and also to *Papaveraceæ* and *Fumariaceæ*, from which they are distinguished by their seeds, and by having no albumen. They are characterised essentially by their deviation from the ordinary symmetry observable in the relative arrangement of the parts of fructification of other plants. Linnæus divided this order into *Siliquosæ* and *Siliculosæ*, from the forms of their fruits; but more recent divisions have been founded upon the nature of the plicature of the cotyledons, and the position of the radicle with respect to them. They all possess antiscorbutic and stimulant properties, combined with an acrid flavour; and their seeds abound in a fixed oil—properties, of which Cress, Mustard, Cabbage, and Rape may be taken as representatives.

Crucifix (Lat. crucifixus, *crucified*). The figure of Christ upon a cross; also a cross with the figure of Christ upon it.

Crude (Lat. crudus, *raw*). In Painting, a term applied to a picture where the colours are rudely laid on, and do not blend or harmonise with one another.

Cruise (Fr. croiser, Dutch kruissen, *to cross*). A voyage within certain limits for the purpose of meeting with enemy's ships, pirates, &c., or for mere exercise.

Cruives. This name is given to a trap for catching salmon; it consists of stone walls built across a river with an intermediate chamber of wooden spars, which the salmon may enter, but from which they cannot escape.

Cruor (Lat.). In Anatomy, the red substance contained in the discs or corpuscles of the blood.

Crupper (Fr. croupière). A roll of leather put under a horse's tail, and connected with the saddle by a strap and buckle, for the purpose of preventing the saddle from being cast forward on the horse's neck by the action of riding.

Crura (Lat.). In Anatomy, are the bundles of nervous fibres which expand into the hemispheres of the cerebrum (crura cerebri) or of the cerebellum (crura cerebelli).

Crusades (Fr. croisade, from Lat. crux, *cross*). In the European History of the middle ages, wars undertaken by confederacies of chiefs and soldiers with a religious object. Those which were engaged in by great part of the nations of Europe for the recovery of

Palestine from the infidels are more frequently denoted by this peculiar name. The term *crusade* is derived from the sacred symbol of the cross, which was borne by the warriors engaged in it over their arms: the colour of the cross often served to designate the nation of the soldier; as the white cross on a red ground, France; the red cross on a white ground, England. The principal crusades for the conquest of Palestine were: 1. The first, A. D. 1096, excited by the preaching of Peter the Hermit and the encouragement of Pope Urban II., in which Godfrey of Boulogne headed the Christians, who made themselves masters of Jerusalem and great part of Palestine. 2. The second, A. D. 1142, in which Conrad III. of Germany and Louis VII. of France led armies to complete the conquest of Palestine, but without success. 3. The third, A. D. 1189, was occasioned by the capture of Jerusalem by Sultan Saladin; Frederick (Barbarossa) of Germany, Philip Augustus of France, and Richard Cœur de Lion of England were the chief among the confederate monarchs: the capture of Acre was almost the only fruit of this great expedition. 4. The fourth crusade was conducted by the king of Hungary, Andrew II., in 1217. 5. The fifth was conducted by Frederick II. (the grandson of Barbarossa), who recovered Jerusalem, but for a short time. 6. The sixth, A. D. 1248, by Saint Louis, king of France, against Egypt, but without success. Among other wars which have been at various times denoted by the name of *crusades*, that against Raymond, count of Toulouse, and his heretical vassals, the Albigeois, of which the first leader was the famous Simon de Montfort, is the most memorable. [ALBIGENSES.] Whether the Crusades exercised a beneficial influence on the state and condition of society, is a question which has long engaged the attention of the learned, and on which the reader may consult with advantage the elaborate work of Michaud, *L'Histoire des Croisades*, and his *Bibliographie des Croisades*; Wilken's *Geschichte der Kreuzzüge*; Haken's *Gemälde der Kreuzzüge*; the art. 'Croisades' in the *Encyclopédie des Gens du Monde*; Milman's *Latin Christianity*, book vii. ch. vi.; Hallam's *Middle Ages*, ch. i. part i. &c.

Crusca, Accademia della. [ACADEMY.]

Crust of the Earth. The name given by geologists to the whole series of stratified rocks coming under human observation. There being no means whatever of knowing the real condition of the earth's interior, it is convenient in speaking of what is positively known to distinguish between theory and observation. The total thickness of the earth's crust penetrated by man is not more than 2,000 feet below the sea, and the highest mountains are less than 30,000 feet above the sea. The actual total thickness of strata at any one point has never been estimated with any approach to accuracy, and is probably greatly overstated in books. It amounts at the most to a very few miles.

Crusta (Lat.). In Gem Sculpture, a gem engraved for inlaying on a vase or other object.

Crustaceans, Crustacea (Lat. crusta, *a hard covering*). A class of free articulate animals, with articulated limbs, a branchial respiration, and a dorsal ventricle or heart. They are classified as follows:—

Subclass: Entomostraca.
Order: Trilobites.
Xiphosura.
Phyllopoda.
Cladocera.
Ostracoda.
Copepoda.
Subclass: Malacostraca.
Division: Edriopthalma.
Order: Læmodipoda.
Isopoda.
Amphipoda.
Division: Podophthalma.
Order: Stomapoda.
Decapoda.
Tribes: Macroura.
Anomoura.
Brachyura.

Cryolite (Gr. *κρύος*, *ice*, and *λίθος*, *stone*, because it melts in the flame of a candle). A rare mineral found only in West Greenland, where it forms a mass 300 feet long and 80 feet thick. It is a double fluoride of aluminum and sodium. It has become an article of commerce as a source of aluminum.

Cryophorus (Gr. *κρύος*, and *φέρω*, *I bear*). The frost-bearer or carrier of cold; an instrument contrived by Dr. Wollaston for freezing water by its own evaporation. (*Phil. Trans.* 1813, p. 71.)

Crypt (Gr. *κρυπτός*, *hidden*). In Architecture, the under or hidden part of a building. The crypt at Canterbury Cathedral is one of the most perfect specimens of this kind of building extant in England.

Crypts. In Botany, the round receptacles for secretion present in the leaves of some plants, as in the orange and myrtle.

Cryptæ. Little rounded excrescences, in which the minute ramifications of the arteries terminate in the cortical part of the kidneys.

Crypteia (Gr. *κρυπτεία*, *a secret commission*). A Spartan institution, attributed to Lycurgus, for the annual secret assassination of the Helots by young citizens sent out for the purpose. For this statement, the authority of Aristotle has been alleged (Plutarch, *Lycurg.* 28); but it is significant that he does not mention it in his treatise on Politics. Yet the existence of a system of espionage, carried on probably by the employment of young Spartans, admits of little doubt. (Grote, *History of Greece*, part ii. ch. vi.)

Crypto-porticus (Lat.). In Ancient Architecture, a concealed portico; also one which, for the sake of coolness, was enclosed on every side. Some of these buildings were sunk to a considerable depth in the ground.

Cryptobranchus (Gr. *κρυπτός*, *hidden*, and *βράγχια*, *gills*). A genus of Batrachia, in which

the gill-aperture disappears early in life. Three species are known, the *Cryptobranchus* (*Menopoma*) *alleghaniensis*, found in many rivers of North America; the *C. fuscus*, from South Carolina; and the *C. japonicus*, which is the largest of all the known naked Amphibia, being three feet long. A fossil species is found in the tertiary strata at Œningen, which Schreber thought to be the bones of a man who had witnessed the deluge (*Homo diluvii testis, et theoscopos*). Cuvier demonstrated this animal to be merely a Salamander, and Van der Hoeven has named it *Cryptobranchus primigenius*.

Cryptogams (Gr. κρυπτός, *concealed*, and γάμος, *marriage*). The distinctive name of the various groups of flowerless plants, in opposition to the name given to those which bear flowers. [PHANOGAMS.] The name, implying hidden marriage, was given on the assumption that they really did possess sexual organs, though they had not been discovered; but the notion for a long time prevailed that these were absolutely wanting, and it was thought that the presence or absence of sexes was the chief distinction between flowering and flowerless plants.

The great distinctive point of Cryptogams does not, however, consist in the absence of decided male and female organs, nor in their minuteness, for in the greater part their presence has now been ascertained beyond all doubt. The main point, as Mr. Berkeley has well expressed it, is that the reproductive organs are not true seeds containing an embryo, but mere cells consisting of one or two membranes enclosing a granular matter. These bodies, whether called spores or sporidia, produce by germination a thread or mass of threads, a membrane, a cellular body, &c., as the case may be, which either at once gives rise to the fruit or to a plant producing fruit. Indeed, the differences are so great that these spores seem rather to be relatives, or what is technically termed *homologues*, of pollen grains, than of true seeds. The consideration of the relations between the reproductive organs of phænogams and cryptogams is one of the most interesting which is to be found in botany, but it is also one of the most abstruse and difficult.

Cryptogams are divided into two principal groups, namely:—

THALLOGENS, those which have the stems and leaves undistinguishable.

ACROGENS, those in which the stems and leaves are distinguishable.

The former of these groups contains the Fungi, Lichens, Seaweeds, and *Characeæ*; the latter, the *Equisetaceæ*, *Hepaticæ*, Mosses, Club-mosses, and Ferns.

Cryptogamic plants are connected with Gymnosperms through *Lycopodiaceæ* and *Equisetaceæ*, with Rhizanths through Fungi, and perhaps with Endogens through tree ferns; they do not appear to have any immediate relation to Exogens.

Cryptography (a word formed from the Gr. κρυπτός, *hidden*, and γράφω, *I write*). Also termed *Polygraphy* and *Steganography*. The art of writing in a manner intelligible only to those admitted into the secret of the method, either by conventional signs (cipher), or by other contrivances.

Cryptoline (Gr. κρυπτός). A fluid discovered by Sir David Brewster in minute cavities of Topaz, Chrysoberyl, Rock-Crystals from Quebec, and Siberian Amethyst.

Cryptolite (Gr. κρυπτός, and λίθος, *stone*). Native phosphate of cerium in which the cerium is partly replaced by didymium. It occurs in small yellow prisms, at Arendal in Norway, embedded in rose-coloured Apatite.

Cryptomorphite (Gr. κρυπτός, and μορφή, *form*). A species of hydrated borate of lime and soda, found near Windsor in Nova Scotia.

Crystal (Gr. κρύσταλλος, *ice*). This term was originally applied to those beautiful transparent varieties of silica, or quartz, known under the name of *rock crystal*. When substances pass from the fluid to the solid state, they frequently assume those regular forms which are generally termed *crystals*. [CRYSTALLISATION.]

Crystalline. [ANILINE.]

Crystalline Lens. The *lens* of the eye, placed in a depression upon the anterior part of the vitreous humour. [EYE.]

Crystalline Rocks. This name is given, in Geology, to such rocks as granite, quartzite, marble and others, which show by their crystalline structure that they have been brought into their present state owing to the action of chemical forces. In the early history of geology, such rocks were called *primitive*, but they are certainly not limited to any geological age, examples being found in the newest as well as the oldest. Even granite is comparatively modern, and there is no reason why crystalline rocks should not be at the present time in course of formation.

Crystallisation, Crystallography (Gr. κρύσταλλος, *a crystal*, and γράφω, *I describe*). The doctrine of the relation of crystalline forms, and of the origin and structure of crystals. Natural as well as artificial crystals occur in an infinite variety of forms; but they may generally be referred to some primary figure, of which these varieties may be regarded as modifications. The structure of crystallised bodies is most easily illustrated by reference to natural crystals, but the theory applies to all crystallised bodies; it assumes the existence of some definite primary figure, which by various truncations may be modified into its secondary forms.

The varieties of calcareous spar may be referred to as presenting one of the easiest illustrations of the mechanical texture of crystals, and of the modifications of which a definite primary figure is susceptible. Calcareous spar occurs in more than a hundred different forms, all of which, by careful mechanical division, are reducible to an *obtuse rhomboid*, whose faces are inclined to each other at angles of 105° 5′; this, therefore, is called the *primary form* of calcareous spar.

The *secondary forms* are presumed to be derived from the primary forms in consequence

of *decrements* of particles taking place upon the edges, or angles, or both, of the primary form. Thus, if the primary form were a cube, it might be reduced to a secondary octahedron by decrements, or *truncations*, in the direction of the planes produced by the removal of its solid angles; and by a similar operation a primary octahedron might become a secondary cube.

The doctrine of the relations and conversions of these forms is, properly speaking, a branch of solid geometry; but its practical applications to chemistry have in fact rendered crystallography a subsidiary branch of that science. By a careful examination of the forms and modifications, the texture and fracture of crystals, the chemist and mineralogist are in many cases enabled to determine their nature or composition; and in some cases a strict examination of such forms may supersede analysis, or other more circuitous methods.

When we attempt by cautious mechanical means to dissect a crystal, we find that it will only yield kindly and afford smooth surfaces when broken or divided in certain directions. A *cube* of fluor spar, for instance, will only give way under such circumstances in the direction of its solid angles or corners; if we pursue the division in such directions, an octahedron will be the resulting figure; and each slice which is removed may be further divided into octahedra and tetrahedra. The new and smooth surfaces resulting from this division or *cleavage* of the crystal are called its *cleavage planes*; the line produced by the meeting of two planes is called the *edge* of the crystal; and the meeting of any two lines or edges forms a *plane angle*. A *solid angle* is produced by the meeting of three or more plane angles. Different crystallographers have assumed various primitive forms as the bases of their respective *systems of crystallisation*. Haüy assumed six (*Traité de Minéralogie*); Mr. Brooke enumerates fifteen primary forms (*Familiar Introduction to Crystallography*); and almost each author upon this subject has adopted different views as regards the number of fundamental forms and the modes of derivation of secondary figures. In Germany the system of crystallography of Mohs is pretty generally adopted. (Haidinger's translation of Mohs' *Mineralogy*.) But any detailed account of these different systems and theories would be inconsistent with our present object. It may be observed, however, that the *theory* of crystallisation is greatly simplified by assuming all secondary forms as resulting from the aggregation of primary spherical or spheroidal molecules. (See a paper on this subject by Dr. Wollaston, in the *Philosophical Transactions for* 1813; and Mr. Daniell's confirmations of the hypothesis in the first volume of the *Quarterly Journal of Science and the Arts*.)

The process of crystallisation is resorted to for many useful and important purposes in the arts: it is the principal means by which various saline products are obtained in a state of purity; for, in the act of crystallisation, they throw off foreign substances and acquire definite composition. It is thus, for instance, that nitre is purified for the manufacture of gunpowder, and that the common and other salts with which crude nitre is contaminated are got rid of; a *crystal* of nitre being of necessity a definite compound of 54 parts of nitric acid combined with 48 of potassa.

Nitre furnishes an instance of what is termed an *anhydrous* crystal; it retains none of the water in which it had been dissolved, and from which it is deposited. There are, however, many salts, the crystals of which are *hydrous*, and in such cases the quantity of water which they contain always bears a certain definite quantitative relation to the elements of the salts. Sulphate of magnesia, for instance, or Epsom salt, forms prismatic crystals, which always contain 51·2 per cent. of *water of crystallisation*: they are constituted of 20 parts of magnesia, 40 of sulphuric acid, and 63 of water.

The details of the various crystallographical systems which have been proposed, could only be made intelligible by woodcuts and diagrams, so numerous as to be inconsistent with the object of this work. The reader is therefore referred, for these details, to the articles on 'Crystallography' in the *Encyclopædia Britannica* and in Watts' *Chemical Dictionary*.

Crystalloids. [Colloids.]

Ctenobranchiata (Gr. κτείς, *a comb*, and βράγχια, *gills*). A name substituted by some naturalists for *Pectinibranchiata*; applied by Cuvier to that order of Gastropods which breathe by means of pectinated gills.

Ctenoides (Gr. κτενοειδής, *like a comb*). A name given by Agassiz to one of his orders of fishes, characterised by scales composed of layers with pectinated or toothed posterior margins. These combs overlapping one another give a rough feel to the skin; the scales are horny or bony, without enamel. The Ctenoid order includes the following families: *Chætodontes*, *Pleuronectes*, *Percoides*, *Polyacanthi*, *Scienoides*, *Sparoides*, *Scorpenoides*, *Aulostomi*.

Cubature. The measurement of the volume of a solid body. If the equation to the surface enclosing the body be given in rectangular coordinates, its volume is expressed by the triple integral $\iiint dx\,dy\,dz$, where the integration is to be extended to all points of the solid according to the methods explained in all text-books. When the equation to the surface is given in polar coordinates, its volume is expressed by the integral $\iiint r^2 \sin\theta\, dr\, d\theta\, d\phi$.

Cube (Gr. κύβος, *a die*). In Geometry, a solid body contained by six equal squares. It is also called *a regular hexahedron*. If a be the number of units of length in any side, then the volume of the cube will be $a.a.a = a^3$ times that of the cube whose sides are equal to the linear unit; or if the latter volume be taken as the unit of measure (*cubic unit*), then a^3 will express the volume of the first cube. Thus in Algebra and Arithmetic the third power of a number, or the product of three numbers equal to it, is called the *cube* of that number.

Cube Ore. A hydrated arseniate of iron, crystallising in cubes.

Cube Root. In Arithmetic, the number whose cube is equal to a given number. In Algebra, the *three* cube roots of any quantity are the three quantities, real or imaginary, each of which, when cubed, reproduces the original quantity. The *three cube roots of unity* are the three roots of the equation

$$x^3-1=(x-1)(x^2+x+1)=0;$$

calling them 1, α_1, α_2, we have obviously for the two *imaginary* cube roots of unity

$\alpha_1=\frac{1}{2}(-1+\sqrt{-3})$ and $\alpha_2=\frac{1}{2}(-1-\sqrt{-3})$. It is manifest that $\alpha_1+\alpha_2=-1$, $\alpha_1\alpha_2=1$, and hence $\alpha_1^2=\alpha_2$, $\alpha_2^2=\alpha_1$; so that representing by α either of the imaginary cube roots of unity, the three roots of the *pure* cubic equation $x^3=a$ are $\sqrt[3]{a}$, $\alpha\sqrt[3]{a}$, $\alpha^2\sqrt[3]{a}$; where the symbol $\sqrt[3]{a}$ denotes the ordinary *arithmetical* cube root of a. [CUBIC EQUATION.]

Cubeba. A genus of *Piperaceæ*, distinguished by its diœcious flowers being partly covered by sessile bracts, and by its fruits being elevated on a sort of stalk, formed from the contraction of the base of the fruit itself. *C. officinalis*, formerly *Piper Cubeba*, furnishes the Cubebs of commerce.

Cubebs. The berries of the *Cubeba officinalis* or *Java pepper*. They have a bitter and aromatic flavour, and contain volatile oil and resin: they are stomachic; and given in a dose of from one to two drachms in powder, two or three times a day, have proved curative in certain forms of *gonorrhœa*.

Cubic. In Algebra, denotes a homogeneous function of the third degree in its variables; in other words, a quantic of the third order with respect to its facients. The general form of a *binary cubic* is

$$(a, b, c, d \between x, y)^3=ax^3+3bx^2y+3cxy^2+dy^3;$$

equated to zero it gives the general cubic equation, having the ratio $\frac{x}{y}$ for its unknown term. Such a cubic has but one invariant, viz. its discriminant

$$a^2d^2+4ac^3+4db^3-3b^2c^2-6abcd.$$

With respect to its covariants, the most important is its Hessian, which has the same discriminant as the cubic itself.

The solution of a *cubic equation* obviously resolves itself into the transformation of the above general cubic to its *canonical form* AX^3+BY^3, by means of linear substitutions $X=\alpha x+\beta y$ and $Y=\alpha_1 x+\beta_1 y$. But it follows from the definition of covariants that the same substitutions will reduce the Hessian to the form $ADXY$. So that X and Y are, to a constant *près*, the two factors of the Hessian, and can be found by the solution of the quadratic obtained by equating the original Hessian to zero. If the roots of the Hessian are real, two of the roots of the cubic will be imaginary; if the former are imaginary, however, all the three roots of the cubic will be real; lastly, the cubic will have a pair of equal roots whenever its Hessian has. The criterion in these cases is furnished at once by the discriminant, which is common to both cubic and Hessian; according as its value is positive, negative, or zero, the one or other of the above three cases will arise.

A *ternary cubic*, equated to zero, represents in coordinate geometry a plane *cubic curve*. The canonical form to which every such cubic is reducible is $x^3+y^3+z^3+6mxyz$. A ternary cubic has two *fundamental* invariants, which were discovered by Aronhold. (Crelle's *Journal*.) One is a quartinvariant, which for the canonical form reduces to $S=m-m^4$; and the other a sextinvariant, which for the same form has the value $T=1-20m^3-8m^6$. Sylvester has shown (*Philosophical Magazine* 1853, and *Cambridge and Dublin Mathematical Journal*) that every other invariant of a ternary cubic may be expressed as a rational function of these two fundamental ones. For instance, its discriminant, which is an invariant of the twelfth order, is T^2-64S^3. With respect to the covariants of a ternary cubic, we will only mention here that its Hessian is another cubic, which for the canonical form is expressed thus:

$$m^2(x^3+y^3+z^3)-(1+2m^3)xyz.$$

The very important properties of ternary cubics will be found scattered in the more recent journals. Hitherto the only attempt to collect them has been made by Dr. Salmon, whose excellent little treatise on the Higher Algebra will be of great assistance to every student of the subject. Quaternary cubics have as yet been little studied. From their connection with cubic surfaces, however, they possess great interest.

The term *plane cubic*, as above remarked, is applied to plane curves of the third order. Since the publication of Newton's *Enumeratio Linearum Tertii Ordinis*, their properties have formed the subject of very numerous investigations. Cubics are naturally classified according to the number of tangents that can be drawn to them from any point in the plane. Thus we have *cubics of the sixth class*, which have neither double point nor cusp; *cubics of the fourth class*, which admit of two varieties according as the only double point which they can possess is a conjugate point or a node; and *cubics of the third class*, which have a cusp, but of course no double point. Another classification is based upon the number and nature of the points of intersection with the line at infinity; and a third on the harmonic properties of cubics. [CHARACTERISTIC OF A CUBIC.] One of the most instructive classifications, however, is due to Newton, who has shown that every cubic is the projection or shadow of a kind of parabola whose equation may be written in the form

$$y^2=A+Bx+Cx^2+Dx^3$$
$$=\lambda(x-a)(x-b)(x-c).$$

Of the parabolas represented by this equation, however, there are obviously five varieties, corresponding to the cases when, of the three quantities, a, b, and c, (1) two are imaginary;

(2) all are real and unequal; (3) the two least are equal; (4) the two greatest are equal; and (5) all three are equal. Besides Newton's classification of cubics, there are others by Euler and Cramer. We have also an elaborate one by Plücker, who distinguishes 219 different varieties (*System der Analytischen Geometrie*); another by Möbius, who divides them into seven species, by considering their *central* projections on a sphere (*Grundformen der Linien der dritten Ordnung*, Leipzig 1849); and another by Bellavitis (*Memorie della Società Italiana*, t. xxv. 1855).

The Hessian of a cubic, or the locus of a point a, whose polar conic breaks up into two right lines, is itself a cubic. The intersection a_1 of these lines is also on the Hessian, and is called the *corresponding point* of the former point a. The Steinerian of a cubic, therefore, coincides with its Hessian. The envelope of the lines $a\,a_1$ is a curve of the sixth order and third class, which has been called by Cremona the *Cayleyan* of the cubic, inasmuch as its properties were first investigated by Cayley (*Phil. Trans.* 1857). Besides the works already cited on plane cubics, many others might be added. We mention only Maclaurin's *Geometria Organica*, Londini 1720; Steiner in Crelle's *Journal*; Chasles and Jonquières in Liouville's *Journal*, and *Comptes Rendus*; Cremona's *Teoria Geometrica delle Curve Piane*; Cayley, Hesse, Clebsch, and others, in Crelle's *Journal*; and Salmon's *Higher Plane Curves*.

A *non-plane* or *twisted cubic* may be regarded as the partial intersection of two ruled quadric surfaces which have a common generator; for instance, as the intersection of two quadric cones; they are always curves of the *third class*, that is to say through any point in space may in general be drawn three osculating planes.

One classification of non-plane cubics into four species has been based upon the nature of the three points in which such a curve meets the plane at infinity. Thus the *cubical ellipse* meets the plane at infinity in one real and two imaginary points, the *cubical hyperbola* in three real points, the *cubical hyperbolic parabola* in three real points, two of which are coincident, and the *cubical parabola* in three real and coincident points. (Salmon's *Analytical Geometry of Three Dimensions*.)

Non-plane cubics appear to have been first examined by Möbius. (*Barycentrische Calcul*, Leipzig 1827.) Since then Chasles, in his *Aperçu Historique*, in Liouville's *Journal*, and in the *Comptes Rendus*; Schröter and Cremona, in Crelle's *Journal*, and in the *Nouvelles Annales des Mathématiques*, have contributed greatly to our knowledge of the subject. Other memoirs by English writers will also be found in recent journals.

Cubic surfaces have only been partially investigated. Upon them can in general be drawn *twenty-seven* right lines, the properties of which were first investigated by Cayley and Salmon in the *Cambridge and Dublin Mathematical Journal*, vol. iv. 1849. A classification of cubic surfaces into five species has been based by Dr. Schlaefli on the real or imaginary character of these lines. (*Quarterly Journal of Mathematics*, vol. ii. 1858.) In the *Philosophical Transactions* for 1863, however, the same mathematician has given a more elaborate classification of cubic surfaces, into twenty-two species, founded upon their class, which varies from the twelfth to the third, and the number and nature of their nodes. Numerous contributions by Cayley, Salmon, Sylvester, Steiner, Chasles, and others to our present theory of cubic surfaces, are scattered in the pages of recent English and Continental journals and proceedings of learned societies. In Dr. Salmon's *Analytical Geometry of Three Dimensions* alone have the principal results of these investigations been hitherto collected.

Cubic Equation. In Algebra, an equation which involves the cube of the unknown quantity. A cubic equation is said to be a *pure* one, when it consists of two terms only; one of which is a simple number. Thus $x^3 - c = 0$ is a pure cubic equation. All other cubic equations are said to be *adfected*. The most general adfected cubic equation can obviously be reduced to the form $x^3 + 3a_1 x^2 + 3a_2 x + a_3 = 0$. The roots of a pure cubic equation are easily found [CUBE ROOT], whilst those of an adfected cubic may readily be deduced from the properties of covariants. [CUBIC.]

An adfected cubic equation was first solved independently, by the Italians Nicholas Tartalea and Scipio Ferrens. Their method of solution, however, was first published by Cardan. It is known as *Cardan's Rule*, and is explained in all text-books.

Cubical Parabola. There are two curves known by this name; one is a non-plane [CUBIC], the other a plane curve. The latter has for its equation $a^2 y = x^3$; it has a point of inflection at the origin and a cusp at infinity. It is of the third class, and has the origin for centre.

Cubicite. A mineralogical synonym for cubic zeolite or Analcime.

Cubinvariant. [INVARIANT.]

Cubit (Lat. cubitus). In Architecture and Sculpture, a linear measure of the ancients equal to the length of the arm from the elbow to the extremity of the middle finger, usually considered about eighteen English inches. The geometrical cubit of Vitruvius was equal to six ordinary cubits.

Cubitus (Lat.). The fore arm; the larger bone or *ulna* of which is called the *os cubiti*. This term is said to be derived from cubo, *I lie down*, from the ancient custom of leaning on that part of the arm when in the recumbent posture at meals.

Cuculinæ (from Lat. cuculus, *a cuckoo*). A name given by Latreille to a family of bees, distinguished by the absence of the femoral plates for transporting pollen, and which are consequently compelled to resort to the combs of other bees in order to deposit their eggs.

hence they may be regarded, like the cuckoo, as a kind of parasite.

Cuculus (Lat. *a cuckoo*). A most interesting genus of Passerine birds, belonging to that group which is characterised by having the toes situated two before and two behind (*Zygodactyli*), and so named from including as the typical species the common European cuckoo (*Cuculus canorus*). The cuckoo is a migratory bird; it arrives in England in the month of April for the purpose of breeding. It differs from almost every other bird in not constructing a nest, nor under any circumstances hatching its own eggs, which it deposits in the nests of other birds, as of the hedge-sparrow. The unfledged young have a remarkable instinct, which impels them to unceasing efforts to expel their helpless companions from the nest, which they effect by pushing them in the hollow of their back to the verge of their nest, and tilting them over, until they at length monopolise all the care and provision of the foster-parent. The young cuckoos of the year do not leave this country till the month of September.

Cucurbitaceæ (Cucurbita, one of the genera). A natural order of diclinous Exogens, inhabiting the hot countries of both hemispheres. They are placed by Auguste de St. Hilaire and De Candolle between *Myrtaceæ*, to which they appear to have little affinity, and *Passifloraceæ*, to which they are so closely allied that they differ only in the sinuous stamens, unisexual flowers, inferior fruit, and exalbuminous seeds. The order is one of the most useful in the vegetable kingdom, comprehending the Melon, Cucumber, and the various species of Gourd. The Cucumber is the fruit of *Cucumis sativus*, the Melon of *Cucumis Melo*; while the Gourds, Vegetable Marrows, Pumpkins, &c. are species of *Cucurbita*. Colocynth is the pulp of *Citrullus Colocynthis*, which is a drastic purgative and intensely bitter. The perennial roots of all the order appear to contain similar principles; especially that of the *Momordica Elaterium*, now *Ecbalium agreste*, which yields the virulent purgative called *elatine*.

Cudbear. The commercial name of *Litmus*, and some other blue and red dyes, derived from certain Lichens. The name seems to have originated from that of their first manufacturer, Cuthbert Gordon.

Cuddy. In small vessels, the name applied to the part where the cooking of the men's rations is carried on.

Cuirass (Fr. cuirasse, from cuir, *leather*). A covering for the breast; originally, as the name denotes, of leather, also of quilted linen, cloth, &c. The cuirass of plate-armour succeeded the hauberk, hacqueton, &c. of mail, about the reign of Edward III.; and from that period the surcoat, jupon, &c., which were usually worn over the coat of mail, began to be laid aside. From that period the cuirass or breastplate continued to be worn, and was the last piece of defensive armour laid aside in actual warfare. There were cuirassiers in the English civil wars, and in the French service nearly to the end of the seventeenth century: after this period, the cuirass was generally laid aside, until it was again employed by some of Napoleon's regiments, and it is now, in most services, worn by some regiments of heavy cavalry.

Cuisses, Cuissots, Cuissarts, &c. (Fr.). In Plate Armour, the pieces which protected the front of the thigh.

Culdees. A religious order, whose origin is attributed to St. Columba, an Irish monk of the sixth century, who evangelised the western parts of Scotland, and founded a monastery in Iona. The word is probably contracted from the Gaelic *Gille De* (or servants of God), words corresponding to the Latin *Cultores Dei*. (Hook's *Church Dictionary*.)

Culex (Lat. *a gnat*). A Linnæan genus of insects, having the common gnat (*Culex pipiens*, Linn.) for its type; but now raised to the rank of a family (*Culicidæ*), including the genera *Megarhina*, *Sabethes*, *Ædes*, *Aropheles*, and *Culex* proper: the two latter are British.

Cullet. The term given to broken glass brought to the glass-house for the purpose of being melted up with fresh materials.

Culm. A provincial synonym of *anthracite*. *Mineral carbon*, *glance coal*, *columnar coal*, are terms also applied to this species of coal, of which Kilkenny coal furnishes an example.

Culm. The stem of grasses, which is hollow and has a peculiar organisation.

Culmination (Lat. culmen, *the top*). The passage of a celestial body over the meridian, at the upper Transit [which see].

Cultivator. An implement of the horse-hoe kind, chiefly used in working fallows. It consists of a frame of iron, into which a number of coulters, or tines, are introduced; which, when the instrument is drawn along lands already ploughed, penetrate to the bottom of the furrow, and thoroughly pulverise the soil.

Cultrate (Lat. cultratus, from culter, *a knife*). Coulter-shaped, as when a body is straight on one side and curved on the other.

Culverin (Fr. couleuvrine, from Lat. colubra, *a serpent*). A cannon of the sixteenth century, at which time cannon were named after serpents, &c. It carried a shot of about 18 lbs. weight. A demi-culverin was about a nine-pounder.

Culvert. An arched channel of masonry, built beneath the bed of a canal, for the purpose of conducting water from under the same; in this sense it may be either a siphon or a surface drain. It is applied in the sense of an arched drain in engineering works upon railways, or analogous structures.

Cumin Seed. The seed or fruit of the *Cuminum Cyminum*. It is imported from Sicily and Malta. It forms an ingredient in *curry powder*, and in some kinds of cheese; it has also been used medicinally, but is unimportant. It has a very peculiar odour, and a bitter and aromatic taste. In poultices and plaisters, it is supposed to promote the dispersion of indolent

tumours. Some of the Roman poets allude to its power of producing pallor and languor. The essential oil of cumin seed is a mixture of a hydrocarbon termed *cymol* (C_{20}, H_{14}), and of an oxyhydrocarbon called *cuminol* or *hydride of cumyl* ($C_{20}\ H_{11}\ O_2 + H$).

Cuminic Acid. An organic acid, formed when oil of cumin is added to fused hydrate of potash. It crystallises in colourless plates.

Cumulant (Lat. cumulans, part. of cumulo, *I heap up*). A term given by Sylvester (*Phil. Trans.* 1853) to the numerator or denominator of the convergent of a continued fraction. [CONTINUED FRACTION.]

Cuneate (Lat. cuneatus, from cuneus, *a wedge*). An animal or part is so called which has the longitudinal diameter exceeding the transverse, and narrowing gradually downwards.

Cuneiform Letters, called *Keilschriften* by the Germans (Lat. cuneus, *a wedge*). The name given to the inscriptions found on old Babylonian and Persian monuments, from the characters being formed like a wedge. This species of writing, as it is the simplest, so it is the most ancient of which we have any knowledge.

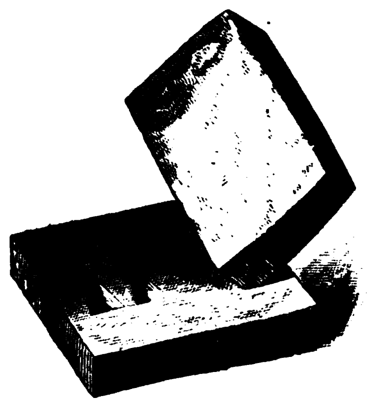
About eighty years ago, a few specimens of inscriptions existing at Persepolis found their way into Europe, and the attention of the learned was directed to the subject. Many German philologists, at the head of whom was the celebrated Tychsen, applied themselves to the task of deciphering and translating these inscriptions with an unrivalled energy and enthusiasm. It was not, however, till the commencement of the present century, when Dr. Grotefend of Hanover engaged in the pursuit, that the mystery in which this species of writing had for so many centuries been involved began to be cleared up. According to him, this mode of writing is formed of two radical signs—the wedge and the angle—susceptible, however, of about thirty different combinations; and consists of three varieties, distinguished from each other by a greater or less complication of the characters. It is of Asiatic origin; is written from right to left, like the Sanscrit; differs from the ancient Egyptian hieroglyphics, inasmuch as it is alphabetic, not ideographic; and, finally, with a few considerable modifications, forms the basis of most of the Eastern languages. The views of Dr. Grotefend received striking confirmation from the researches of Mr. Rich. A full exposition of this species of writing would prove one of the most valuable accessions to modern literature; but the only direct results by which this study was long followed may be stated to be the translation of a few minor inscriptions, and the establishment of a canon so extremely arbitrary, that it was very problematical if the labours of others in the same field could be materially benefited by it. Within the last few years a new impetus has been given to the prosecution of this study by the numerous facts brought to light on the spot through the intrepidity of Botta, Rawlinson, and Layard; but the method of interpreting these inscriptions and the certainty of its results have recently been called in question by Sir G. Cornewall Lewis, in his work on the *Astronomy of the Ancients*.

The origin of the cuneiform letters has more lately engaged the attention of Mr. James Nasmyth, to whom we are indebted for the following remarks:—

'There appears to be one general principle to which the distinctive form of all alphabetic writing owes its origin, namely, the peculiar nature of the materials employed in the primitive ages of the people who originated the alphabetic character in question. Whatever be the material employed to write upon or write with, the nature of the material will be certain to influence the form of the character produced; so much so, that however time and circumstances may cause a change in the selection of materials employed, a greater or less traditional exactness will be adhered to in the copy of the original prototype character.

'Among the many examples which attest this fact, there does not exist a stronger one than in the case of the cuneiform character, which had its origin in the fact of the early Assyrian nations employing the mud of their river banks as their building material in the form of bricks. To that circumstance we may most reasonably trace and assign the origin as well as the peculiar form of the cuneiform character. Not only does the cuneiform character make its earliest appearance in bricks and pottery, but it is so absolutely identified with plastic material, that in order to reproduce it in its original integrity of form, as well as by the most simple means, we must have recourse to clay, in the condition of a soft brick for the tablet, and the corner angle of a dried brick for our "style" or inscribing implement.

Fig. 1

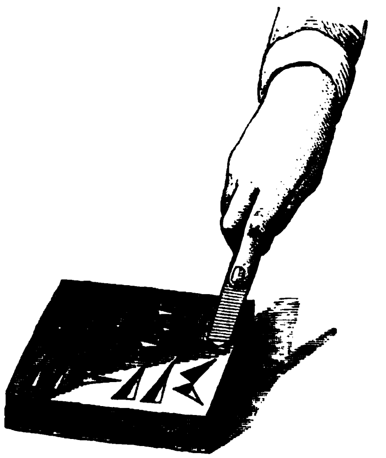


'Reference to fig. 1 will show how perfectly these simple agents will enable us to produce the cuneiform character.

'Accident or intention may thus have produced it in the first instance, and led to the use of a more handy tool for inscribing than the corner angle of a dried brick; certain it

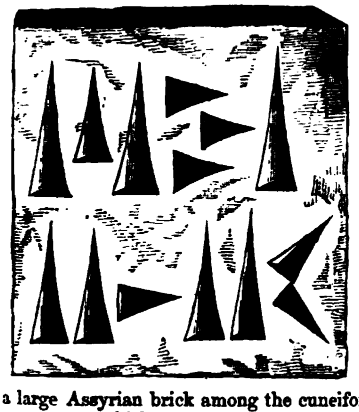
is, however, that the corner angle of a dried brick will give us the means of inscribing on the side of a soft brick or clay tablet every size and variety of cuneiform character, and in the absence of any certain in-

Fig. 2



formation on the subject this may be taken as a reasonable explanation of its origin. Be that as it may, there can be no doubt as to the fact that in its earliest stages of developement it was written on surfaces of soft clay by means of a "style," having all the structural powers or inscribing properties of the corner angle of a brick, with the advantage of greater handiness. That such was the form of the style employed and such its mode of use, the author had the good fortune to prove by the discovery

Fig. 3

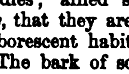


of a large Assyrian brick among the cuneiform characters on which the "style" had been so deeply impressed as to leave an absolute record of its size and exact form.

'It is one of the many remarkable qualities of this strikingly beautiful alphabetic character, that the selfsame "style" can produce any size and variety of character by simply modifying the extent of depression into the clay surface or by varying the position of the axis of the style as to direction, or angle of depression in respect to the surface of the clay tablet.

'However complete the arrangement of the character, or varied the size of the letters or words, if we may so term them, they are all found to consist of the one element  which so distinctively marks this character.

'When the cuneiform came to be applied to hard materials, certain slight modifications of form were introduced, but in no case greater than might be expected from change of material, time, and people. The clay prototype proclaims itself to the eye; and such was the pertinacity of traditional adherence to the cuneiform original, that even when ages had passed and the very language disappeared and became changed to the Greek, as in the case of the Assyrian-Greek collections, the Greek letters cut in marble by these people and their descendants have the cuneiform character strongly marked in them, as the most cursory glance at such Greek inscriptions will abundantly testify, as thus:

and in conclusion it may be well to remark, as an instance of the pertinacity with which certain shapes and forms are clung to long after the causes that led to their origin have departed, that in the capital letters of our modern alphabet we find in the cross-strokes of such capital letters unmistakable evidence of cuneiform origin in the feature in question. The only variation in the modern letter is this: the cross stroke is parallel to the line of letters or at right angles to it, whereas in the Assyrian-Greek inscriptions it is at right angles with the axis of the limb of the letter, as thus:  each limb being in fact a cuneiform.' [ALPHABET.]

Cunette (Fr.). In Fortification, a narrow ditch in the middle of a dry ditch, serving as a drain, or if filled with water, as an obstacle to the enemy.

Cunoniaceæ (Cunonia, one of the genera). A natural order of arborescent or shrubby Exogens, inhabiting South America and the East Indies; allied so intimately to *Saxifragaceæ*, that they are only distinguished by their arborescent habit and interpetiolar stipules. The bark of some species is used for tanning leather.

Cupel (Fr. coupelle). A shallow and porous earthen vessel, somewhat of a *cup* shape, generally made of bone earth. It is used in the assays of the precious metals, which are fused upon a cupel with lead. *Cupellation* means the refining of gold or silver upon a *cupel*.

Cupid (Lat. Cupido). The Roman name of the god of love. Cicero speaks of three

divinities under this appellation (*De Nat. Deor.* 3. 23.); but the one usually meant when spoken of without any qualification was the son of Mercury and Venus. He is generally represented as a beautiful child with wings, blind, and carrying a bow and quiver of arrows. [EROS.]

Cupola (Ital.). In Architecture. [DOME.]

CUPOLA. The term applied to the furnace used in batteries for heating shot to be fired against shipping.

Cupping (from the *cup shape* of the glasses used in its performance). In this operation a cup-shaped glass is used, into which the large flame of a spirit lamp is momentarily introduced, so as to expel a great part of its air by dilatation; it is then instantly applied to some part of the body, which is forced into it by the external pressure; and on removing the glass a circular red mark is left, from the propulsion of the blood into the small vessels of the part: this is called *dry cupping*. It is generally followed up by making a number of incisions in the part by means of an instrument called a *scarificator*, from which the blood oozes, and from which a considerable portion may be drawn by again applying the cupping glass. Cupping, when well performed, is not a very painful or disagreeable operation, and is an excellent mode of local blood-letting. When the operator is not dexterous, it is not only painful, but often dangerous in its consequences. The bleeding may generally be easily stopped by a piece of lint or soft rag; but this should be looked after, as instances have occurred of persons bleeding to death from the wounds of a scarificator.

Cuprammonium. The hypothetical positive radical of a salt obtained on passing ammoniacal gas over hot chloride of copper.

Cupric Acid. A peroxide of copper supposed to be formed when copper, potash and nitre are fused together.

Cuprocyanogen. A compound radical contained in the double cyanide of copper and potassium.

Cuproplumbite. A double sulphide of lead and copper found in Chili, in granular masses of a lead-grey colour, with a metallic lustre and a cubic cleavage.

Cupule. In Botany, the cup or husk of the acorn and similar fruits, forming a sort of involucre.

Cupuliferæ or **Cupbearers.** Another name for the *Corylaceæ*.

Curaçoa. A liqueur which derives its name from the island of Curaçoa. It is prepared in great perfection by the Dutch, and derives its flavour from Seville orange peel, with a small quantity of cinnamon and mace.

Curarine. An alkaloid contained in *Curara*, the Ourari, Wourali, or Arrow Poison of the South American Indians.

Curassoe. [CRAX.]

Curate (Lat. curare, *to take care*). Properly, an incumbent who has the cure of souls; now generally restricted to signify the spiritual assistant of a rector or vicar in his cure. Curates form the lowest order of the clergy; and are divided into two classes, perpetual and stipendiary. 'Perpetual curates are such as are appointed to the churches of those parishes in which the tithes were appropriated to some monastery before the statute 4 Hen. IV. making it necessary to endow a vicar, or which had from some cause or other escaped its operation;' or they are such as officiate in some chapel: in either of which cases, their salary is usually paid by some fixed payment, or by a portion of the tithes appropriated for their maintenance at the foundation of the chapel. Stipendiary curates are such as are appointed by the vicar or rector to officiate at their churches in their stead. As to these, the law was regulated in 1838 by the Act 1 & 2 Vict. c. 106, which gives the bishop power to require their appointment, or himself to appoint, where the incumbent is non-resident, or the duties are inadequately performed, &c., and in large benefices (above 500*l.* per annum and 3,000 population) in addition to the resident incumbent. Salaries to be fixed according to the scale appointed by the Act. In cases of non-residence, the curate is to be allowed under certain restrictions the use of the parsonage house. (Cripps, *Law relating to Church and Clergy*, 1857.)

Curator (Lat.). In a general sense, signifies a person who is appointed to take care of anything. Among the ancient Romans, there were officers in every branch of the public service to whom this appellation was given: thus we read of *Curatores aquarum, frumenti, viarum, operum publicorum, Tiberis*, &c. &c.: i.e. persons who distributed corn, superintended the making of roads and the public buildings, or were conservators of the river, &c.—Curator, in the Civil Law, is the guardian of a minor who has attained the age of fourteen. Before that age, minors are under a tutor. The guardianship of persons under various disabilities, and of the estate of deceased or absent persons and insolvents, is also committed to a *curator*. In learned institutions, the officer who has charge of libraries, collections of natural history, &c. is frequently styled *curator*.

Curb Roof. In Architecture, a roof in which the rafters, instead of continuing straight down from the ridge to the walls, are at a given height received on plates, which in their turn are supported by rafters less inclined to the horizon, whose bearing is through the medium of the wall plates, directly upon the wall. It presents a bent appearance, as in the diagram, whence it derives its name; it is also called the *Mansard* roof, from the name of the celebrated French architect who very frequently resorted to its use.

Curcas. A genus of *Euphorbiaceæ*, comprising the Physic nut, *C. purgans*, a plant which differs from *Jatropha* in having a bell-shaped instead of a five-petaled corolla. It is a bush of tropical America, cultivated for the purgative oil of its seeds.

Curculio (Lat. *a weevil*). A Linnæan genus of Coleopterous insects, now the type of an extensive family, *Curculionidæ*, or weevils belonging to the Tetramerous section of the order. The prolongation of the anterior part of the head, in the form of a proboscis or snout, at once distinguishes the insects of the present family from all other beetles. The number of the *Curculionidæ* may be imagined when it is stated that entomologists have found it necessary to distribute them into nearly three hundred subgenera. They are all vegetable feeders, and include some of the most dangerous enemies to the vegetable stores of mankind.

Curcuma (Arab. kurkum). This genus of *Zingiberaceæ* yields Turmeric and Zedoary, the former being produced by *C. longa*, the latter by *C. aromatica* and *C. zedoaria*. The tubers are the parts used, and they are pleasant aromatics. Turmeric enters into the composition of curry powder.

Curcumin. An amorphous resinous colouring matter contained in turmeric root.

Curetes (Gr. Κούρητες). In Greek Mythology, the Cretan attendants of Zeus, or Jupiter, who watched over him in his infancy. In the *Iliad*, the Curetes are mentioned as the adversaries of the Ætolians, who were defeated by Meleagros at Calydon. (Thirlwall, *History of Greece*, vol. i. ch. iv.) [CORYBANTES.]

Curfew (from the French couvre-feu, in modern Latin ignitegium). The practice of tolling the church bell at eight or some other hour in the evening, to warn people to extinguish their fires, was a very common one in the middle ages. It is difficult to say on what foundation the common tradition, that William the Conqueror introduced it from Normandy to prevent the English from assembling in the evening to plan schemes of rebellion, rests. It is more probable that the Conqueror enforced a very common police regulation. The real reason of the curfew was to prevent fires. The custom of ringing the evening or curfew bell is still retained in many places. (Brand's *Popular Antiquities*, vol. ii. pp. 136, 137.)

Curia (Lat.). [CURIES.]

Curies, Curiæ (Lat.). A subdivision of the Roman patrician tribes, each of which were divided into ten *curies*. These *curies* probably contained originally ten houses (*gentes*) each. These houses were similar to the Scottish clans, in which, though the bond of union was supposed to be that of common blood, yet in reality there was no consanguinity between many of the component families. The building in which the senate held its meetings in Italian cities was called *curia*. There were several such curiæ in Rome.

Curl. A disease in potatoes, in which the leaves on their first appearance appear curled and shrunk up; and consequently, as they do not present a sufficient surface to the light to elaborate the sap in a sufficient manner for carrying on the growth of the plant, it never acquires strength, and either dies, or produces very imperfect tubers. The cause of the disease in the first instance is generally supposed to be the unhealthy state of the set; but something also may be owing to bad management and improper soil.

Currant. The fruit of two species of *Ribes*; namely, *R. rubrum*, which furnishes the common red and white currants; and *R. nigrum*, which produces the black currant. The currants of the grocers' shops (so called from Corinth, as the chief mart for this fruit) are the dried berries of a small species of grape cultivated in Zante, Cephalonia, and Ithaca; and in the Morea in the vicinity of Patras. These so-called currants are largely imported into Great Britain, and the entries of currants for home consumption for the year 1863 amounted to 768,312 cwt., of the computed real value of 981,137*l.*, and yielding in the form of customs duties 268,924*l.*

Currency (from Lat. curro, *I run*). In Political Economy, a generic term employed to designate the conventional measure of value, whether the measure be immediate, as gold and silver coin, or substitutive, as bank-notes and their analogies. The term MONEY will be treated below, and will be limited to the sense of a metallic circulation; at present we may make a few remarks on the wider and more significant word, *currency*.

The recognition and employment of a measure of value is as essential to all but the simplest operations of exchange, as the recognition and employment of language is to all but the simplest operations of thought. Society exists by the interdependence of individuals, and in the reciprocity of services; the progress or developement of society, from an economical point of view, consisting in the continual subdivision of occupations, for the purpose of greater efficiency and economy in the production of whatever objects form the services or utilities offered. But in order that these services should be rendered, they must be called into existence by a demand, and this demand can be effectual only when a service of another character is offered, the significance of which is sufficient to dispose to an exchange between the two services or utilities. With a view to the determination of such an act of exchange, it is almost always necessary that the respective utilities or services should be measured by some standard of value well and familiarly understood between the contracting persons, and this standard must be of such a kind as is liable, among other qualities, to the fewest possible fluctuations in its intrinsic or absolute value. For the same reason of comparative invariability in absolute value, this conventional measure will also satisfy another essential condition; that, namely, of being universally acceptable as a means for interposing a period, more or less protracted, before the entire completion of an act of exchange. For example, A produces shoes and B produces bread. But A may want bread before B wants shoes. The exchange, however, between the parties may still take place by the intervention of currency. If B receives this medium, he takes

it on the faith that, whenever he pleases hereafter, he may complete the exchange with A by the purchase of shoes, or may employ the right to shoes assigned to him by the transfer of a portion of currency, in procuring any other utility which he may desire. Hence a sale has been said to be half an exchange.

If we bear in mind that the radical significance of a currency lies in the facts of its being acceptable on the ground of its generally equal or persistent value, and of its satisfying a seller from its being transferable for nearly equal quantities of utilities at a deferred period, we shall find no great difficulty in interpreting almost all practical questions which arise in connection with currency. The basis of a circulating medium must be a commodity which, being produced in nearly equal quantities by nearly equal labour, is, as has been said, of nearly equal absolute value. If two commodities of this kind are discovered and employed, they must not only possess, separately, the characteristic of general invariability, but if both are employed simultaneously as media of exchange, they must possess also a relative invariability. (See below, *Double Currency*.)

Now, nothing has yet been discovered which possesses separately or relatively these characteristics except the metals gold and silver. Not that this quality is the sole cause for the general acceptance of these commodities as media of exchange, but this is the fundamental and essential reason for their selection. The existence of a measure of exchange is a primary condition of economical society; it may be to some extent satisfied, in the total absence of the precious metals, by the substitution of a fictitious measure; and some of the native tribes in the interior of Africa, where the precious metals are unknown, are said to use a mere mental fiction in order to measure values; but it is impossible fully to satisfy the conditions of the act of exchange, except by the interposition of these metals, or, if it might be discovered, by some other commodity possessing in a still more distinct manner the characteristics of gold and silver.

These metals, then, form part of the machinery of exchange; an expensive part, because, as we have seen, they are selected at once from the fact of their exceptional fitness for the function they fulfil, and because they cost great labour in the acquisition. Were they procured cheaply, even though the condition of equal quantities of labour were continued in their production, much of this utility would be lost, because, though still an efficient measure of value, they would be cumbrous and inconvenient. To retain their place, they must be *dear*.

It must be borne in mind that the agent in any economical process is always striving to procure or produce the greatest possible results with the least possible expenditure of labour. This natural impulse is further intensified by the principle of competition. Labour, to have a value, must be undertaken for some ulterior purpose, and, if we say that each person desires to get an increasing quantity for his labour, we are only stating in a different set of words that he wishes to shorten or economise his labour as much as possible, and to exhibit equal or greater results at less cost. Hence it is that labour is divided, and that all possible forces, natural and artificial, as, for instance, the natural force of running water and the artificial force of steam, are appropriated by the ingenuity of man—an ingenuity developed, as far as society is concerned, wholly from the principle of competition.

Now what applies to individuals applies also to society at large, or rather to political communities. They desire, unconsciously perhaps, but quite as effectively, to diminish, as far as possible, the expense attending the employment of the machinery of exchange. Hence, even in the face of all the administrative restrictions imaginable, they will always employ just as much of these precious metals for the purposes of exchange as they need, and no more. The quantity needed varies very little when the process of exchange is regular and undisturbed, but increases and diminishes by the pressure of certain events, or even by the contingency of these events. As an inference from what has been stated, there is always a tendency towards diminishing the quantity of the currency to the least possible amount consistent with the wants of the community, and the forecast of these contingencies, while all laws and regulations, however much they may multiply or precipitate these contingencies, are inadequate to prevent any evasion by which every possible economy in this expensive material may be achieved.

One of the earliest means by which this economy is effected is by the substitution of tallies or tokens for the metallic currency itself. Even if this substitution had nothing to recommend it but the saving of wear and tear in the metals, and in the supply of a means for more readily identifying and securing the right to a claim on the metal by the presentation and delivery of the tally or token, the means in question would have a great importance in diminishing the cost of the monetary machinery. Hence, in the imperfect economies of the ancient and mediæval world, substitutes for metallic currency were well known, in the shape of banker's tallies and bills of exchange. It will be manifest, if an actual transfer of cash from one town to another were necessary in all transactions between the trades of either locality, that a far larger amount of metallic currency would be needed than is actually required when bills authorising mutual payments take the place of such a metallic transfer. Whether, indeed, these tallies and bills of exchange were circulated by transfer or endorsement in those remote periods or not, is a question difficult to determine.

Modern societies, however, have not been slow to discover that certain documents purporting a right to claim a specified portion of the precious metals at a specified place or places, are, provided they can be framed in such a way as makes fraud practically impossible, a powerful means towards an economy of the expensive

machinery of the precious metals. Of course, the acceptance of such a document in lieu of the metallic currency is only possible in case the recipient has no doubt that he can appropriate, at his pleasure, the amount specified in the instrument. But if this confidence exists, the paper will have all the practical value of the metals or coins which it represents, in somewhat the same way as writing will represent language, and be received in communications as equivalent to spoken words.

This, however, is not all the effect even of the most familiar of these representations of money, the bank-note. It has been found possible to calculate in a general way, and with every allowance for contingencies, the amount of metallic currency which will be demanded in exchange for these notes. This amount falls far short of the quantity which society will accept and circulate. Not, indeed, that it will circulate a single note beyond its collective needs. Society is no more disposed to accept and use any superfluous quantity of these notes, than willing to circulate more than the requisite quantity of the precious metals. As has been proved over and over again, any attempt on the part of bankers to employ this form of issue beyond the needs of the public is a certain failure, provided, of course, that no compulsion is used to circulate the note; or, in other words, provided the note in question is convertible into cash at the discretion of the holder. The public may, and indeed often does, demand more of these notes than the bank is empowered or disposed to issue, but it will never use more than it wants. And it wants, in the ordinary course of trade, as much of these notes as will enable it to dispense with as much as possible of the expensive machinery, coin. And thus the issue of bank-notes makes it possible for a community to abandon, to some extent, the use of the precious metals, and to make a real and comparatively inexpensive addition to its measure of value.

It would be, however, a great mistake to imagine that coin and notes were the only forms of currency. Whatever is a substitute for metallic money is as effectually a kind of currency as gold and silver are, and fulfil just as completely the functions of these commodities. The use of banker's cheques, of private cheques, of bills of exchange, and all other analogous securities, is in reality a substitution of a cheap for an expensive machinery. It would be idle to speculate on the question whether it would be possible for commerce to be carried on, were these expedients abandoned; but of one thing we may be quite sure, that, if they were not used, the amount of the precious metals necessary to liquidate the common business of the country would be four or five times greater, at the least, than what is necessary now, and therefore cost a great deal more. For instance, suppose the amount of gold and silver needed by the public were one hundred millions, and the abandonment of the system of substitutive currency necessitated a multiplication of this amount by five, we should put what would be practically a debt of four hundred millions on the nation, without any real value received.

It will not be difficult perhaps to see, under these circumstances, why it is that the creation of these additional forms of currency (always, be it remembered, worth anything only on the full confidence that they are convertible into cash at the personal discretion of the holders) has at different periods produced so marked and beneficial an effect on the general resources of the community which has adopted them. The existence of commercial confidence is in itself a great stimulus to industry; the actual addition to the currency is another cause; the economy of the machinery of trade is a third. When the circulation is purely metallic, its course is languid, and its quantity is indeterminate; but when the securities referred to have been created, they exist entirely for the purpose of trade, and individually fulfil many more acts of exchange than an equal amount of the precious metals could possibly accomplish.

The effects, indeed, of adopting these substitutes, are so singular and immediate, that we need not marvel at the fact that many fallacious interpretations have been put upon them, and even that occasionally some courses of action have been entered on, in which, by the simulation of some among the characteristics of a sound substitutive currency, and the omission of others, consequences destructive in the worst sense have ensued.

The reader will bear in mind, that the only basis for these securities is the confidence of the holder that they can be transformed at his discretion into that which alone, ultimately and fundamentally, fulfils the conditions of a currency—the precious metals. But persons have occasionally imagined that it would be possible to circulate notes expressed in money values, but based on other values, as land, shares in companies, public debts, and the like. No harm ordinarily ensues to society at large when such notes are convertible, because, as we have said, no individual will take them for more than they are worth, nor will society accept more than it needs. But it occasionally happens that the experiment is made by governments, or is enforced by governments under the machinery of a compulsory circulation. In this case the failure of the scheme is inevitable, the consequences are disastrous, the suffering is extreme, and the injury to credit is lasting. In the first place, to promise money, and give something else, is a fraud; and in the next, what people want as a means of exchange, is not money's worth, but money. The very fact of a compulsory circulation is an indication that the currency is not, on its own merits, worth its nominal value, and that, consequently, the issue is as great a robbery on the public as the circulation of base money. In practice the evil is greater, because it takes but a very short time for these securities to become worthless, when their repudiation is inevitable. Such was the history of Law's bank under the Regency, of the South Sea bubble, of the French assignats

and mandats, and, in a degree, of the American currency during the War of Independence. It would seem that the French and the Americans are peculiarly liable to this monetary fallacy, for there have been occasional indications of an attempt on the part of the former people to employ the securities of the Crédit Foncier as a form of currency, and the history of banks in the United States has too often been a mere record of these mischievous and destructive schemes.

On the other hand, the policy of the government of this country, under the auspices of Sir Robert Peel, has been restrictive; the power of issuing notes being at once limited in amount, and assigned practically to a single corporation; for the issues of the county banks form but an inconsiderable portion of the gross amount of notes in the hands of the public. It is not possible to enter here into the details of this celebrated measure, and the reader is referred to the authorities quoted below. But, primâ facie, the Bank Act of 1844 sins against the principles of free trade. It professes to give a security to the note, when it would seem that the most efficient security, one that has never been wanting in the past history of the bank, lay in the confidence of the public; and it absolutely prohibits the issue of such accommodation as the varying exigences of the circulating medium require. It has always broken down under pressure, as in 1847 and 1857, and assuredly in times of legitimate necessity it raises the rate of discount and depresses trade, not only by the diversion of a larger portion of mercantile profits into the hands of bankers and bill-discounters, but by virtually rendering a profitable trade impossible. It may be perhaps useful to have, for scientific purposes, so delicate a barometer as the register of the bullion in the Bank; but when the abstraction of a small portion of that bullion creates a monetary storm, it may be worth while to consider whether the operation of the Act is not equivalent to wilfully making the vessel of commerce wholly unseaworthy.

It might be acknowledged that the inconveniences of the Bank Charter Act would have been utterly intolerable, had it not been for the economy induced by the machinery of the Clearing House, and by the almost universal adoption of banking accounts. By these means, the insufficient currency is husbanded and reserved. Still, the very machinery by which the evil is met, becomes a means by which the severity of a commercial crisis is aggravated. (Tooke's *History of Prices*, and *Tracts on the Currency*; Mr. J. S. Mill's *Political Economy*, vol. ii. pp. 202 sqq. ed. 1862; Lord Overstone's *Currency Tracts*; and *passim* the works of M'Culloch and Torrens.)

Inconvertible Currency.—Governments sometimes give their own paper, or the paper of some institution under their control, a forced circulation. When a paper currency is convertible, it cannot, as we have seen, be extended beyond the amount which the community requires. But when a currency is inconvertible, it may be issued to any amount, and be made to circulate extensively. The immediate effect of such an issue is to displace the metallic currency, which is either hoarded or exported; for the new circulating medium being overvalued by comparison with the metallic currency, and being of compulsory acceptance, no one will pay in the dearer medium. A very small premium on the precious metals is sufficient to banish them from circulation, though, if the issue of compulsory paper be moderate, it may not be very much depreciated. But generally the circumstances under which the expedient of a compulsory paper is adopted, necessitate or suggest an over-issue, and then the depreciation may be very rapid, and ultimately the paper may become even worthless. The rate at which such a paper is circulated, indicated by its metallic estimate in foreign exchanges, is generally proportioned to the extent to which its holders trust to its final liquidation in full, and on the predictions they make as to when the liquidation will take place. It is almost superfluous to say, that this confidence is never very strong; and as, during such a compulsory circulation, the question as to whether a depreciated currency should be ultimately redeemed at its full value is sure to obtain a hearing, and be answered by many in the negative, the tendency of such a paper is always to depreciate.

Double Currency.—The only community in which a legal tender can be now made at pleasure in either of the two metals, gold and silver, is France. By a law of March 28, 1803 (7 Germinal year xi.), the proportion fixed between the two metals was 15½ to 1. This arrangement slightly undervalued the customary proportion of gold, and hence gold was rarely seen. But since the great discoveries of that metal in Australia and California, the relation has been slightly reversed, and silver is undervalued. The consequence is, that gold has been to a great extent substituted for silver, and the latter metal exported in vast quantities. It appears likely, however, in consequence of the discovery of new methods for extracting silver from certain ores in which it exists in small but notable quantities, and by the great cheapening of quicksilver, consequent also on opening mines of this metal in California where it has been found in great abundance, that the margin of oscillation will be considerably narrowed.

The inconveniences of a double currency are obvious. In the first place, if the oscillations are rapid and considerable, it gives an unfair advantage to debtors. In the second, it induces more fluctuations in the quantity of the precious metals than occur when a single standard is used, and so renders the foreign exchanges more capricious. Thirdly, it causes that the reserves of the undervalued metal should be liable to serious diminution. And lastly, it tends to annul the advantage which the less valuable metal possesses—its use, namely, for small purchases.

In our own country, the standard, or actual currency, is gold. Silver and copper are issued, indeed, but are so much overvalued that they could not be exported in the shape of coin; they are therefore secured to circulation, the extent of the overvaluation being regulated so as to obviate the risk of private coining. Silver is overvalued by about 10 per cent., copper by about 100. But silver is no legal tender for more than forty shillings, nor copper for more than twelve pence, or, if offered in farthings, for sixpence. As these tokens are issued by the Mint, they are received at that establishment at their nominal value when worn.

Currency is sometimes used by way of contrast with other rates of value. For instance, at Hamburg, *currency* is opposed to *banco*, the agio in favour of the latter being about 22½ per cent. So in Canada, *currency* is opposed to *sterling*, the agio on the latter being 20 per cent.

Currents, Electric. [ELECTRICITY.]

Currents, Earth. [MAGNETISM.]

Current, Marine. Currents in the ocean arise from various causes, either occasional or constant. They may be occasioned by an external impulsion, as by a gale of wind; from a difference in the temperature of different parts of the sea; from the inequality of evaporation, the melting of the polar ice, or in short any cause tending to disturb the hydrostatic equilibrium. It is difficult in many cases to trace their causes, or to give any satisfactory theory of their existence; but on account of their importance to navigation they have been observed, especially of late years, with great care. Among those which have a permanent or general character, there are two which are very remarkable. The first is that of the tropical waters westward round the globe, and the second that which constantly flows from each pole towards the equator. The tropical or westerly current is chiefly confined within the zone extending to about 30° on each side of the equator, and its velocity is estimated by Humboldt at about nine or ten miles a day. In the Atlantic it separates into two branches; one of which forms the GULF STREAM, and the other flows along the coast of Brazil, and passes through the straits of Magellan.

In the Pacific the currents are not so well known, nor are they quite so definite as in the Atlantic. But there is one group both interesting and important. Commencing as a drift current in the Antarctic Ocean, the water runs along the west coast of South America towards the equator, and then westward, and is gradually converted into the EQUATORIAL CURRENT, which, after crossing the Pacific, enters the Indian Ocean, and passes between Madagascar and the African coast, forming the MOZAMBIQUE CURRENT, and losing itself as it rounds the Cape of Good Hope in the Atlantic Ocean.

Besides the Atlantic and Pacific currents, there are others directly connected with and derived from the Arctic and Antarctic Oceans. [POLAR CURRENTS.] There are also deep currents apparently flowing in directions opposite to those of the surface currents.

The whole waters of the great ocean are thus kept in a constant state of admixture, both with regard to temperature and saltness. The climates of the coasts washed by them are modified, and the general balance of organic life is kept up.

Curriculum (Lat.). The ground traversed in a race, or *course*, and thence, in academical language, the whole *course* of studies completed in a university or similar institution.

Currying (Fr. corroyer). The art of dressing skins after they are tanned, for the purposes of the shoemaker, saddler, harness-maker, &c.; or of giving them the necessary smoothness, lustre, colour, and suppleness. The operation of currying is performed in two ways; either upon the flesh (or inner side), or on the hair (or outer side), or, as it is technically called, the *grain*; and consists chiefly in beating or pummelling the skin, smoothing and dressing it, and finally imbuing it with certain oily matters, so as to render it supple and waterproof.

Cursitors (Lat. cursito, freq. of curro, *I run*). Officers in the Court of Chancery, whose duty it is to make out original writs. Cursitor Baron was the name of an officer in the Court of Exchequer, who formerly administered oaths, &c.; abolished by 19 & 20 Vict. c. 86.

Curtail Step. The lower step in a flight of stairs, ending at its outer extremity in a scroll projecting beyond the ordinary line of the staircase.

Curtain (Fr. courtine, Ital. cortina). In Fortification, that part of the rampart of the body of the place, which lies between two bastions, and joins their two flanks together.

Curtana. The sword (as it is called) of Edward the Confessor, which has its edge blunted as an emblem of Mercy. It is carried between the swords of justice temporal and justice spiritual, and borne before the kings of England at their coronation.

Curtate Distance. A term employed in Astronomy to denote a planet's distance from the sun reduced to the plane of the ecliptic. The curtate (or shortened) distance is therefore equal to the true distance multiplied by the cosine of the planet's heliocentric latitude.

Curtesy or Courtesy of England. In Law, is the right of a husband who has married a wife seised in fee simple or fee tail general, or heiress in special tail, and has issue male or female born alive, and which by possibility may inherit, to hold her lands after her death for his life. [MARRIAGE, LAW OF.] Thus, four things are said to be necessary to give an estate by the curtesy: marriage, seisin of the wife, issue, and death of the wife.

Curule Magistracies. In Ancient History, were those of the greatest dignity in the Roman state; and were distinguished from all others by the privilege enjoyed by the persons who held them of sitting on ivory chairs (*sellæ*

curules) when engaged in their public functions. The curule magistrates were the consuls, prætors, censors, and chief ædiles, which last, on account of this privilege, were called *curule* to distinguish them from the plebeian ædiles.

Curvature (Lat. curvatura, *a bending*). In Plane Geometry, the amount of bending or deflection of a curve from its tangent at any point. The circle, being the curve whose curvature is uniform, is always used, as a measure of the curvature of other curves; that is to say, the curvature at any point of a curve is the same as that of the osculating circle at that point. Now in any circle the deflection from the tangent corresponding to a unit arc is inversely proportional to its radius, so that the *reciprocal of the radius of a circle is a measure of its curvature.* This granted, the curvature at any point of a curve is expressed by the ratio

$$\frac{1}{\rho}=\frac{d\tau}{ds},$$

where ds is the arc-element and $d\tau$ the angle between two successive normals. This angle, which is obviously equal to that between two successive tangents (angle of contact or contingence), is called also the *angle of curvature*. The radius of the osculating circle, or circle of curvature, as it is often called, is termed the *radius of curvature*; its value in rectangular and polar coordinates is given in all treatises.

Curvature, Absolute. The curvature of the osculating circle of a non-plane curve. The term *absolute* is employed in consequence of such curves possessing a *second curvature* or *torsion* in virtue of which they are continually deflected from a plane.

Curvature, Geodesic. The geodesic curvature at any point of a curve traced upon a given surface is the ratio, to the arc-element of the curve, of the geodesic angle of contact, that is to say, of the angle between the geodesic lines touching the curve at the extremities of this arc-element. The reciprocal of this ratio is termed the *geodesic radius of curvature*, and its value is $\frac{\rho}{\sin\phi}$, where ϕ is the angle between the normal to the surface and the principal normal to the curve, and ρ the radius of absolute curvature of the latter. Just as the plane has a geometry of its own, so also has every other surface; right lines on the former represent geodesic lines on the latter, and what was ordinary curvature becomes replaced by geodesic curvature.

The term *geodesic curvature* appears to have been suggested by Liouville, and first adopted by Bonnet in his memoir on the theory of surfaces. (*Journal de l'École Polytechnique*, cah. 32, 1848.)

Curvature, Line of. A line traced upon a surface such that the normals at any two consecutive points meet one another. Since of all the normals to a surface at points consecutive to a given one, only two meet the normal at that point, and the planes containing the latter normal and the two former are always at right angles to one another, it follows that through every point of a surface pass two lines of curvature which cut one another perpendicularly, and are touched by the two principal normal sections. The normals to a surface along a line of curvature form a developable surface which cuts the given surface perpendicularly, and has with it the curve of intersection for a common line of curvature. This follows as a consequence of the general theorem that when two surfaces cut one another everywhere at the same angle, the curve of intersection will either be a line of curvature on both or on neither. The cuspidal edge of the above developable is a geodesic line on the *surface of centres* of principal curvature, this surface being such that each of its two sheets is touched by every normal of the original surfaces in such a manner that the tangent planes at the points of contact coincide with the principal planes of section through that normal.

The beautiful and important theory of lines of curvature originated with Monge, and is given in his *Application de l'Analyse à la Géométrie*. His researches have been extended since by others, amongst whom must be mentioned Dupin, to whom we owe the elegant theorem concerning three series of surfaces so related to one another that the surfaces of each series cut all those of the other two series perpendicularly. Any individual of such a system of *orthogonal surfaces* is intersected in its lines of curvature by the two series of surfaces to which it does not belong. (Dupin's *Développements de Géométrie*, p. 239, Paris 1813.) A system of confocal quadrics satisfies the above conditions, the surfaces of one system being ellipsoids, those of the second hyperboloids of one sheet, and those of the third hyperboloids of two sheets, whence a clear conception may be obtained of the lines of curvature on any surface of the second order. This conception, too, is rendered still clearer by another interesting theorem relative to quadrics, which was discovered by Mr. Michael Roberts (Liouville's *Journal*, vol. xi. p. 1); according to it the sum (or difference) of the geodesic distances from two umbilics of all points on the same line of curvature is invariable. Thus a line of curvature on an ellipsoid may be constructed mechanically in the same manner as an ellipse on a plane.

Curvature, Measure of. This expression, as applied to curves, has already been defined. [CURVATURE.] Gauss, however, in his classical *Disquisitiones generales circa Superficies Curvas*, has extended the definition to surfaces. In the first place, he defines the *total curvature* of any portion of a surface to be the area intercepted upon any unit-sphere by radii drawn parallel to the normals erected at the several points of the contour of the portion of the given surface under consideration. This premised, the measure of curvature at any

point of a given surface is the ratio, to the surface-element around the point, of the total curvature of that element. The measure of curvature is easily shown to be equal to the reciprocal of the product of the two principal radii of curvature. It is consequently positive, negative, or zero, according as the point is elliptic, hyperbolic, or parabolic. [CURVATURE OF SURFACES.] Instructive information on this important subject, as well as references to original memoirs bearing thereon, will be found in Salmon's *Analytical Geometry of Three Dimensions.*

Curvature, Spherical. The term *spherical curvature,* as applied to a non-plane curve, denotes the curvature of any great circle of the osculating sphere. The *radius* and *centre of spherical curvature* are respectively the radius and centre of this sphere.

The curvature at an *umbilical* point of a surface is also said to be spherical, and a line every point of which is an umbilic on the surface is called a *line of spherical curvature.*

Curvature of Surfaces. The curvature of a surface at any point may be considered as determined by that of the plane sections through the point. Such sections, however, are of three kinds: 1. *Principal normal sections,* of which there are two, at right angles to each other, each containing the normal of the surface as well as a consecutive normal; 2. *Ordinary normal sections,* of which there are an infinite number, each containing the normal at the point but no other; and 3. *Oblique sections,* whose planes are inclined to the normal. The sections of the first kind are sections of maximum and minimum curvature. The curvature of every other section is determined from that of each of these sections of *principal curvature.* The methods of finding the *centres* and *radii* of *principal curvature* are given in every treatise on surfaces. The radius of curvature ρ of any normal section is given by the following important formula, due to Euler,

$$\frac{1}{\rho}=\frac{\cos^2 a}{\rho_1}+\frac{\sin^2 a}{\rho_2},$$

where ρ_1 and ρ_2 are the *principal radii* of *curvature,* and a the angle between the plane of normal section and that of the principal normal section whose radius of curvature is ρ_1. Lastly, the radius of curvature ρ' of any *oblique section* is determined from that ρ of the normal section, whose plane contains the tangent of the oblique section, by means of the following formula,

$$\rho'=\rho\cos\theta,$$

where θ is the angle between the planes of normal and oblique section. The circles of curvature, therefore, of the normal and oblique sections are, respectively, a great and a small circle of one and the same sphere whose centre is in the normal. This is *Meunier's Theorem.* In using the above formulæ it is necessary to bear in mind that the sign of a radius of curvature changes according as the convexity of the section is turned in one or the other direction. When the principal radii of curvature have the same sign, so also have those of every normal section, and the curvature all round the point, which is called an *elliptic point,* is of the same character. When the principal radii are equal, their common value is obviously shared by the radius of curvature of every other section; the point of a surface at which this occurs is called an *umbilical* point, and the curvature there is said to be *spherical.* Every point of a sphere is an umbilic, and in an ellipsoid there are always four such points situated in the plane of the greatest and least axes. When the principal radii of curvature have opposite signs, every other normal section has a *numerically* greater radius of curvature, and there are two directions equally inclined to the principal normal sections for which the radius of curvature is infinite. A point on a surface where the curvature is of this kind is called a *hyperbolic* point, and the tangent plane at it cuts the surface in two straight lines, *inflexional tangents.* [INDICATRIX.] In two of the opposite angular spaces between these tangents, the surface is *above* the tangent plane, in the other two *below.* The shape of a saddle is a familiar illustration; another is the hyperboloid of one sheet through every point of which two straight lines can be applied to the surface. Lastly, when one of the radii of principal curvature is infinite, Euler's formula takes the form

$$\rho=\frac{\rho_2}{\sin^2 a},$$

and the two inflexional tangents coincide; such a point on a surface is called a *parabolic* point. [INDICATRIX.] Every point of a cone or of a developable surface is of this kind.

Curvature, Total. As applied to the arc of a plane curve, this expression denotes the arc of a unit circle which is traced by the extremity of a radius constantly parallel to the normal of the curve, as the latter moves from one to the other extremity of the given arc.

The total curvature of any portion of a given surface has already been defined. [CURVATURE, MEASURE OF.]

Curve (Lat. curvus). In Geometry, is synonymous with *line,* and might, according to Euclid, be defined as that which has length, but neither breadth nor thickness. A curve may also be regarded as the locus of points whose positions are determined by some uniform law, usually expressed by one or more equations between the coordinates of those points. The term *curve,* involving as it does the conception of curvature or departure from a right line, is strictly speaking inapplicable to the latter; as synonymous with *line,* however, the term *curve* is also frequently applied to this simplest of all point-loci.

When the plane drawn through three points of a curve passes through all its other points, the curve is said to be *plane.* When this condition is not satisfied, the curve is called a *non-plane* or *twisted* one, and frequently also a *curve of double curvature.*

Curves are further distinguished as *algebraic* or *transcendental*, according as the coordinates of their several points satisfy algebraic or transcendental equations.

A *plane curve* may not only be regarded as the locus of a movable point, but also as the envelope of a right line (tangent) variable in position. In both cases the curve may be represented by a homogeneous equation in three variables, the latter denoting in the first case the trilinear coordinates of any point, and in the second case the three-point coordinates of any tangent. The *degree* of the trilinear equation will indicate the number of points, real or imaginary, in which the curve is cut by any right line in its plane; the degree of the three-point equation, on the other hand, will give the number of tangents to the curve which pass through an arbitrarily chosen point. We are thus led to distinguish algebraic curves in two ways: a curve is said to be of the m^{th} order when it is intersected by every right line in m real or imaginary points, and of the n^{th} class when, through every point in its plane, pass n real or imaginary tangents. In the former case the curve is frequently called a plane m-ic, since its trilinear equation involves a quantic of the m^{th} order. [QUANTICS.]

A curve is further characterised by the possession of certain singularities, such as double and stationary points and tangents, the number of which depends upon the order and class of the curve, as was first shown by Plücker in his *System der analytischen Geometrie*, Berlin 1835. [SINGULARITIES OF CURVES AND SURFACES.]

Through

$$\frac{m\,(m+3)}{2}$$

given points it is always possible to draw a curve of the m^{th} order, and in general only one; for the general equation of the m^{th} degree contains

$$\frac{(m+1)\,(m+2)}{1\cdot 2}$$

terms [COMBINATIONS], and therefore one less than this number of *independent* constants. For exceptional positions of the points, however, the curve so determined may not be a proper curve of the m^{th} order, but may consist of a system of curves of inferior order. For instance, a conic can be drawn through any five points, but when of these five, three are situated in a right line, the conic necessarily breaks up into a pair of right lines. And in general no *proper* m-ic can be drawn through

$$\frac{m\,(m+3)}{2}$$

points, of which more than

$$m\,r-\frac{(r-1)\,(r-2)}{2}$$

lie on a curve of inferior order r. Again, the positions of the

$$\frac{m\,(m+3)}{2}$$

given points may be such as not completely to determine the curve of the m^{th} order, and whenever this happens an infinite number of curves may be drawn through the points, all of which will pass through

$$\frac{m\,(m-3)}{2}$$

other fixed points; namely, those which, with the given points, make up the m^2 intersection points of any two curves of the series. Thus through the nine intersection points of two cubics $U=0$ and $V=0$ will pass every cubic represented by the equation $U+\lambda, V=0$, where the parameter λ may have any value whatever. In fact, every m-ic through

$$\frac{m\,(m+3)}{2}-1$$

of the m^2 intersections of two other m-ics will necessarily pass through all the rest. A system of curves of the m^{th} order passing through the same m^2 *fundamental points* is called a *pencil of curves*, of which the m^2 points constitute the *base*. Curves of higher order may often be advantageously generated by means of such pencils, just as conics are by means of pencils of lines. [CONIC SECTIONS.] On this subject the reader may consult an excellent memoir by De Jonquières in the *Mémoires présentés par divers Savants à l'Académie des Sciences*, tome xvi. Similar remarks apply to the determination of a curve of the n^{th} class by means of given lines which touch it.

Non-plane curves, considered as loci of points movable in space, are also divided into *orders*, the term *order* here indicating the number of points in which the curve is intersected by an arbitrary plane; hence, adopting the terminology of quantics, non-plane curves of the third, fourth, &c. orders are frequently called *cubics*, *quartics*, &c., the adjective *non-plane* or *twisted* being added when required. The complete intersection of two surfaces of the m^{th} and n^{th} orders respectively is obviously a curve of the mn^{th} order, which may be represented by the equations of these surfaces. It is not always possible, however, to find two surfaces whose intersection coincides precisely with a given curve; there is in general an embarrassing extraneous curve which, together with the given one, constitutes the complete intersection in question. A *twisted* cubic, for instance, cannot be the complete intersection of any two surfaces whatever, since the only factors of 3 are 1 and 3; it may be, however, and usually is, regarded as the *incomplete* intersection of two ruled surfaces of the second order (cones or hyperboloids) which have a common generator.

The tangents of a non-plane curve, or the lines joining pairs of consecutive points, lie on a developable surface called the *developable osculatrix*, each of its tangent planes being an osculating plane of the curve, i.e. a plane through three consecutive points. Every plane through a tangent touches the curve, of course, in the same point as the tangent itself, and the number of such *tangent planes* which can be

drawn through an arbitrary line in space, or, what is the same, the number of tangents which meet such a line, determines the *class of the curve*. By applying Plücker's equations connecting the singularities of plane curves to the plane projections of a twisted curve, as well as to the plane sections of its developable osculatrix, Mr. Cayley has succeeded in establishing the relations which exist between the singularities of any curve whatever. (*Cambridge and Dublin Mathematical Journal*, vol. v.) [SINGULARITIES.]

The properties of non-plane curves are of two kinds, *projective* and *non-projective*. The former do not involve the consideration of angles, whilst the latter have reference to the curvature, torsion, evolutes, &c., of the curve. One of the best treatises on this subject is that of St. Venant in the *Journal de l'École Polytechnique*, cahier xxx. A more recent one has been published by P. Serret (*Théorie Nouvelle des Lignes à double Courbures*, Paris 1860), and by Schell (*Allgemeine Theorie der Curven doppelter Krümmung in rein Geometrische Darstellung*). The most important non-projective properties of curves, however, are given in all modern text-books. Dr. Salmon's *Analytical Geometry of Three Dimensions* contains a very able exposition of their principal projective properties.

Curvograph. [ARCOGRAPH.]

Cuscutaceæ (Cuscuta, one of the genera). A very small natural order of Exogens, consisting of but one genus, inhabiting all the quarters of the globe, and related to *Convolvulaceæ*; but distinguished by the imbricate corolla which does not fall off after flowering, the spiral embryo, and the parasitical habit. Common dodder, a curious thread-like twining parasitical plant, found on heaths, belongs to the order.

Cushion Capital. A form of capital described by Whewell as being common in Romanesque work in England and on the Continent. It consists of large cubical masses projecting considerably over the shaft of the column, and rounded off at the lower corners.

Cusp (Lat. cuspis, *point*). In Architecture, a term applied to express the projecting points of the featherings, or foliations, in Gothic panels, arches, or tracery.

CUSP. In Astronomy, the points or horns of the moon or one of the inferior planets.

CUSP. In Geometry, a *stationary point*. It may also be regarded as a double point at which the two tangents to the curve coincide, and constitute the *cuspidal tangent*. (As an illustration, see CISSOID.) There are two kinds of cusps, distinguished as *ceratoid* and *ramphoid*. The former is simply a stationary point at which the two branches of the curve lie on opposite sides of the cuspidal tangent; at the latter there is not only a stationary point, but likewise a stationary tangent, so that both branches of the curve lie on the same side of this tangent. A ramphoid cusp, therefore, constitutes a singularity of higher order than a ceratoid cusp.

Cusparia Bark. [ANGUSTURA.]

Cuspidal Edge. The curve enveloped by the rectilinear generators of a developable surface. The points in which such a curve is cut by any plane are all cusps of the section of the developable by that plane. The term *cuspidal edge*, which had its origin in this property, is synonymous with *edge of regression*, and in any envelope whatever denotes the locus of the intersections of successive characteristics. [CHARACTERISTIC OF AN ENVELOPE.]

When any plane section of a cone has a cusp, the generating line through the same is also called a *cuspidal edge of the cone*.

Cuspidal Tangent. [CUSP, in Geometry.]

Cuspidate (Lat. cuspidatus, from cuspis, *a point*). In Botany, a term used in describing the apex of a body, when it gradually tapers into a rigid point. It is also used sometimes to denote what is abruptly acuminate, as the leaflets of many *Rubi*.

Custard Apple. A term applied in the West Indies to the fruit of the *Anona reticulata*.

Custom (Fr. coutume, Span. costumbre, from Lat. consuetudo). In Law, signifies generally a right or law not written, but established by long usage. To render a custom valid, it has been said that the following qualities are requisite: 1. Antiquity; i. e. that it shall have been used as far back as time of legal memory, that is, the first year of Richard I.; 2. Continuance without interruption; 3. Without dispute; 4. It must be reasonable; and 5. Certain; 6. Compulsory; 7. Customs must be consistent with each other. Customs in derogation of the common law must be construed strictly. General customs, relating to all England, are determinable by the judges; but local customs by a jury. An exception to this rule is to be found in the *Custom of the City of London*, which, if questioned, is established by certificate of the mayor and aldermen; with the exception of those customs from which the corporation itself claims a benefit. *Customs* (*coutumes*), in the law of France, were the laws relating both to movable and immovable property peculiar to different districts of the kingdom before the Revolution. Districts governed by customs were commonly termed *pays coutumiers*, in contradistinction to the remainder of the realm, which being under the civil law was termed *pays de droit Romain*. The pays coutumiers embraced all the north of France. The valid *coutumes* were estimated at 140 *general*, or comprehending districts, and 360 *local*, belonging to towns and places; but the enumeration was not exact. The *coutume de Paris* was the most important of all; and it was a generally recognised principle that when a case was unprovided for by local custom, that of Paris was to be applied in aid. Works containing the customary law of a particular district are styled *coutumiers*.

Customary Freehold. In Law, is a superior kind of copyhold; the tenant holding, as it is expressed, by copy of court roll, but not at the will of the lord. [COPYHOLD.]

Customs. A privilege, existing time out of mind (as is indicated by the name), by

which the king or his deputy took tolls on *imports*; analogous in their nature to the customary tolls of market towns, held and appropriated by the several lords of the manors in which the market was situate. Occasionally *export* duties were levied, especially on wool and hides, the staple products of this country during the middle ages; and these duties were also loosely called *customs*. In later times customs duties were known by the names *tonnage* and *poundage*: the former being apparently derived from the fact that the ancient custom on wine was a tun from before and behind the mast, if the vessel held twenty tuns of wine; and the latter from a primitive ad valorem duty, levied for instance in the year 1347, at the rate of sixpence in the pound. The city of London was exempted from the payment of customs by special charter, 1 John, June 17, 1199.

Tonnage and poundage were generally granted to the crown for life, the renewal of the grant being the earliest business of the first parliament summoned at the king's accession. Apparently (Parry's *Parliaments and Councils*) the first record of this practice is at the commencement of the reign of Henry VII., though according to *Parliamentary History* (vol. ii. p. 6) it had been the first formal act of every reign from the beginning of the fifteenth century. The first parliament of Charles I. granted tonnage and poundage for one year only, but the upper house rejected their bill. From this time, therefore, till the debates which followed on Charles's qualified acceptance of the Petition of Right, it was enacted at the sole will of the crown, and the king (June 29, 1628) prorogued the parliament on its remonstrance against the exaction. (Parry, pp. 325, 326.) Several merchants declined payment, and were distrained; among them Mr. Rolles, a member of the house. The question whether the exaction was legal was prominent among the debates during the remaining existence of this parliament, which was dissolved for this reason on March 10, 1629. What followed is matter of general English history. It is sufficient to say that tonnage was, eo nomine, abolished in 1696, and that the exigences of the wars entered upon by William III. with Louis XIV., and the necessity for securing further credit by the appropriation of supplies, condemned the ancient and clumsy customs system. (Macpherson's *History of Commerce*, vol. ii. p. 676.) At the accession of William III. tonnage and poundage were estimated at 600,000*l*. (Davenant's *Works*, vol. i. p. 20.)

After the Revolution, provision was made for the payment of public debts, or rather precautions were taken against their repudiation. Hence they were secured on the proceeds of particular taxes, and among these taxes enlarged and modified customs duties were about the most common. If, as was sometimes the case, the produce of the tax exceeded the annual charge, the balance was paid over to the general purposes of the Exchequer, and this separation of the produce of one duty from another, or, what was sometimes the case, the distinction drawn between the purpose of one part of the aggregate customs charge and another, was a serious hindrance to commerce. 'The many additions of customs to customs, excise to excise, and stamps to stamps, had altogether accumulated to such a mass of duties, that merchants and other individuals, finding it impossible to obtain a knowledge of the amount, or even the number, of the duties which they had to pay, were obliged to leave it entirely to those clerks of the custom-house or excise-office, who by constant practice had acquired a dexterity in it, to determine the amount of the duties payable. The separation of every branch of the duties in the office accounts, owing to each of them having been appropriated for paying the interest of some particular branch of the national debt, was also found productive of great perplexity.' (Macpherson's *History of Commerce*, vol. iv. p. 124.) The remedy for these inconveniences was the creation of the *Consolidated Fund*.

Originally all duties were leviable on the entrance of the vessel into port. The circumstances which led to an alteration of this rule, so very onerous to the public (because it often charged the duty long before consumption) and of no benefit to the government (because the receipt of the duty was just as advantageous if it occurred as near as possible to the act of consumption), will be adverted to under the head of WAREHOUSE, BONDED.

In the infancy of finance, the incidence of a customs duty was very imperfectly understood, and the administration constantly interpreted an addition to a customs duty as identical with a tantamount increase of revenue. Experience, however, has shown that such an anticipation is liable to large corrections, though financiers have been very slow to comprehend and act upon the inductions of this experience. A high duty checks consumption to an extent larger even than an equivalent increase of price, because its effects are inevitable and permanent, while an increase of price may be corrected by diminution of general consumption and be only temporary. In other words, an increase of price has a tendency to correct itself by only affecting some; an increase of taxation has no such tendency, because it affects all. And again, high duties are a powerful stimulus to the practice of smuggling. If a high duty leaves a large contingent rate of profit to parties who are disposed to evade the revenue laws (and there are, and perhaps always will be, many such persons), the practice of smuggling becomes general and frequently successful. Nor does it appear that any precautions will check this kind of trade, be the revenue officers ever so active and incorruptible. The smuggler plans his operations in secret, and is always at a point of time considerably in advance of the detective. Napoleon's Berlin decree was inadequate to exclude English goods, even from those parts of the Continental markets which

were brought within the limits of his administration; and it is well known that during the existence of a Spanish tariff virtually prohibitive, the chief value of Gibraltar consisted in its being a smuggling dépôt. Again, as is well known, an effective blockade is all but an impossibility, for when the profits of a successful venture are very great, the risks may be great also, without checking the attempts to elude the blockade intended to prevent the importation of commodities.

Up to the tariff reforms of Sir Robert Peel in 1845, the number of commodities liable to customs was enormous, almost every conceivable article of foreign produce being charged with import duties, some of them being even on raw materials. But since that time the success of Peel's legislation has been so marked as to form a precedent for the simplification of the customs system, so that at present the following articles only are subject to duty: chicory, cocoa and coffee, corn of all sorts with flour and meal, certain kinds of highly saccharine fruits and confectionery, plate of foreign manufacture, pepper, spirits, sugar, tea, tobacco, vinegar, wine, and wood.

With two exceptions, these customs are levied on articles, to a greater or less extent, of voluntary use. The exceptions are corn and timber. As to a very great degree the fiscal system of this country is characterised by its adding to the price of articles in voluntary use, by the levy of a tax upon the use of such commodities, the system of customs duties at present in force is, on the whole, a well-balanced and satisfactory arrangement. It is understood that these duties are collected merely as a tax on expenditure, not as a protective scheme (with some few unimportant exceptions), still less as a sumptuary check. It may be disputed on abstract grounds, whether customs duties are a desirable source of revenue. But if they are, the principle on which they are at present levied is, with two exceptions, just and judicious.

The exceptions are corn and timber. For every reason, it would be matter of the greatest prudence to abolish all duty on corn. Dependent as the people of this country are, and to secure their industrial precedence among nations must be, upon the importation of food, it would be in the highest degree desirable that this country should be as effectually the entrepôt of grain as it is of the precious metals. The interposition even of a duty of one shilling a quarter, is as certain to check the accumulation of foreign corn in any country, as the impost of sixpence on the ounce of gold, or on the pound of silver, would divert the accumulation of these metals to other and wiser communities.

The case of the customs on timber is analogous to that of duties on corn, though not perhaps so strong. It is manifest that house-room is a necessary of life, and that any pressure of taxation which falls on absolute necessaries is, both on rational and economical grounds, a public injury. The evil, too, is exaggerated when, as is the case with all necessaries of life, the proportion of expenditure devoted to their acquisition is in a ratio increasing with the poverty of the purchaser. And when we consider the effect of the tax on timber employed for mills, manufactories, and warehouses, we find that all the evils which attend taxes on raw material, that is on commodities not available for consumption except at some protracted period, apply to such imposts. The burden and loss of the tax to those who pay it, either directly or indirectly, is considerably greater than the amount received by the Exchequer. An annual tax, for instance, on each spindle employed in a spinning mill, if proportioned to the charge contained in the outlay for the timber employed in constructing the mill, would be much less onerous to the public at large than the tax paid at once for the raw material of the structure; and this for the reason that taxes levied on raw materials multiply in the process of use and manufacture, till they come to present an increased charge in the product, frequently many times in excess of the tax originally imposed. [Duty; Excise; Tariff; Taxation.]

Custos Rotulorum. The first civil officer of a county is so called, as being keeper of the rolls or records of the sessions of the peace. The lord-lieutenant is always appointed to this office, although it is, in itself, quite distinct from the lieutenancy.

Cut-in, or In-cut, Notes. In Printing, side-notes which are not arranged in the front margin down the side of the page, but are inserted in the text by shortening the lines, as if a piece of the text were cut out, and the note put into the vacant space.

Cuticle (Lat. cuticula, dim. of cutis, *skin*). In Anatomy, the scarf skin. The exterior membranous covering of the body. In its chemical characters it resembles nail, quill, &c., and has the properties of a condensed form of albumen.

Cuticle. In Botany, the thin vesicular membrane that covers the external surface of vegetables, and adheres firmly to the cellular substance beneath it. It acts in plants as a means of preventing a too rapid perspiration, and is furnished with respiratory openings called *stomata*.

Cutlass. A broadsword, about three feet long, and of great weight, used by sailors in hand-to-hand encounters.

Cutlery (Fr. coutellerie, from couteau = Lat. cultellus, *a knife*). A term used to designate all kinds of sharp and cutting instruments made of iron or steel, as knives, forks, scissors, razors, &c. The principal seat of the manufacture of British cutlery is Sheffield; and the articles made there are held in the highest estimation in all parts of the world. [Hardware.]

Cutter. A vessel with one mast and a bowsprit, of considerable breadth in proportion to her length. The distinction between a cutter and other vessels of one mast, which are called *sloops*, is, that in the cutter the jib has no *stay* to support it.

Cutwater. The apex of the wedge formed by the bow of a ship or boat. It is an extension forwards of the beam at which the planking meets which covers the two sides of the ship. The cutwater helps to cleave the water in which the ship is making her voyage.

Cyamelide. A white solid, resulting from a spontaneous molecular rearrangement of hydrated cyanic acid.

Cyameluric Acid. An organic acid formed on heating mellonide of potassium. When isolated, it is a white semicrystalline solid.

Cyanamide. White crystals formed on evaporating an ethereal solution of ammonia, into which chloride of cyanogen has been passed. By substituting other ammonias for the ordinary, corresponding cyanamides are formed.

Cyanethine. A crystalline polymeride of cyanide of ethyl, from which it is formed by the action of potassium.

Cyanic Acid. An intensely corrosive liquid, produced when cyanuric acid is distilled. *Cyanates* are formed by oxidising cyanides.

Cyanic Ether. A volatile liquid composed of cyanic acid and oxide of ethyl.

Cyanides, Cyanurets. Compounds of cyanogen. Prussian blue is a cyanide of iron.

Cyanilic Acid. A crystalline body closely resembling cyanuric acid. Formed on boiling hydromellon with nitric acid.

Cyaniline. A direct compound of cyanogen and aniline. It is somewhat unstable, but crystallises and forms salts with acids.

Cyanin. The colouring matter of red and blue flowers. Alcohol extracts it from the petals of the violet or iris. Alkalies turn it blue and green, acids redden it.

Cyanite (Gr. *κυανός*, *blue*). A massive and crystallised mineral. It has a pearly lustre, is translucent, and of various shades of blue. It is a silicate of alumina, with a trace of oxide of iron. Only found in primitive rocks.

Cyanogen (Gr. *κυανός*; because it is an essential ingredient of Prussian blue). Cyanogen is a gas of a strong and peculiar odour, resembling that of rubbed peach leaves; it is obtained by heating *cyanide of mercury*. Under a pressure of between 3 and 4 atmospheres it becomes a limpid liquid. It extinguishes a taper, is highly poisonous and unrespirable, and burns in contact of air with a rich purple flame. Water absorbs between 4 and 5 times its volume of the gas. It is composed of carbon and nitrogen in the proportions of 12 carbon + 14 nitrogen = 26 cyanogen; it is therefore a bicarburet of nitrogen. Mixed with oxygen it explodes by the electric spark, and is resolved into carbonic acid and nitrogen gases. It combines with hydrogen to produce the *hydrocyanic* or prussic acid. It forms with the metals *cyanurets* or *cyanides*.

Cyanolite (Gr. *κυανός*, and *λίθος*, *stone*). An iridescent bluish silicate of lime, forming the central part of a nodule found in crystalline trap-rock in the bay of Fundy. [CENTRALLASSITE.]

Cyanometer (Gr. *κυανός*, and *μέτρον*, *measure*). An instrument contrived by Saussure for determining the deepness of the tint of the atmosphere. A circular band of thick paper or pasteboard is divided into fifty-one parts, each of which is painted with a different shade of blue, decreasing gradually from the deepest blue formed by a mixture of black, to the lightest formed by a mixture of white. The coloured zone is held in the hand of the observer, who notices the particular tint which corresponds to the colour of the sky. The number of this tint, reckoned from the lightest shade, marks the intensity at the time of observation.

Cyanosis (Gr. *κυάνωσις*). In Medicine, the *blue disease*. A blueness of the body occasionally arises from malformation of the heart. The whole of the body, and especially its exposed parts, often acquire a blue or lead colour, in consequence of the administration of nitrate of silver.

Cyanosite (Gr. *κυανός*). Native sulphate of copper. This salt is rarely found in distinct crystals, but generally in stalactitic and other forms in the fissures and hollows of old mines, or dissolved in the waters which issue from them. In the latter case metallic copper is frequently procured by placing fragments of scrap-iron in the water, by which sulphate of iron is formed and metallic copper precipitated.

Cyanurets. [CYANIDES.]

Cyanuric Acid. A crystallisable acid obtained by decomposing urea by heat.

Cybele (Gr. Κυβέλη or Κυβήβη). In Mythology, is supposed to have been originally the Phrygian goddess of the earth. When her worship was introduced among the Greeks, they identified her with Rhea, as did the Latins with their Ops. Her rites, like those of the Asiatic deities, in general were celebrated with great excitement; her priests, who were called Galli, Corybantes, Curetes, &c., running about with howlings and clashing of cymbals.

Cycadaceæ (Cycas, one of the genera). In Botany, a very small natural order of arborescent Gymnosperms, inhabiting the tropics of Asia and America. They are very nearly related to *Coniferæ*. They are known by their simple stems, pinnate leaves, and antheriferous cones. The vessels contained in the wood of both orders are of the same structure. The only remarkable quality in the *Cycadaceæ* is the production of a kind of sago by the soft centre of *Cycas circinalis*.

Cycadeoidea. A name given by Buckland to a genus of fossil dycotyledonous plants: the genus *Mantellia* of Brongniart.

Cycadites. A genus of dicotyledonous fossil plants.

Cyclamin. [ARTHANITIN.]

Cyclantheæ (Cyclanthus, one of the genera). In Botany, a section of *Pandanaceæ* inhabiting the tropics of the western hemisphere, and distinguished from *Pandaneæ* by their plaited, flabellate, or pinnate leaves and spiral scaly flowers.

Cyclas (Gr. *κύκλος, a circle*). A genus of fresh-water air-breathing Gastropods or snails, so named on account of the more or less rounded circumference of the shell in all the species. Of these the following are natives of Britain: the river cycle (*Cyclas rivicola*, Leach), the largest species of which is not uncommon in the smaller streams communicating with the Thames; the horny cycle (*C. cornea*, Lam.), common in ditches near Battersea; cupped cycle (*Cyclas calyculata*, Drap.); lake cycle (*Cyclas lacustris*, Drap.).

CYCLAS. An article of dress worn both with and without defensive armour, which came into fashion about the reigns of Edward II. and Edward III. in England. It was a mantle or surcoat without sleeves, of silk, cloth, &c., reaching to the knees before and to the calves of the legs behind. It was succeeded by the jupon or gyppon, a shorter kind of surcoat.

Cycle (Gr. *κύκλος*). The revolution of a certain period of time which finishes and recommences perpetually. Cycles were invented for the purposes of chronology, and for marking the intervals in which two or more periods, of unequal length, are each completed a certain number of times, so that both begin again exactly in the same circumstances as at first. The cycles used in chronology are three: the *cycle of the sun*, the *cycle of the moon* or *Metonic cycle*, and the *cycle of indiction*.

The *cycle of the sun*, or solar cycle, is a period of time after which the same days of the week recur on the same days of the year. If the number of days in the year were always the same, this cycle could only contain seven years: but the order is interrupted by the intercalations. In the Julian calendar the intercalary day returns every fourth year, and the cycle consequently contains $4 \times 7 = 28$ years; after which period the Dominical letters return in the same order, or the first day of the year and of every month falls again on the same day of the week. The origin of this cycle is unknown; it is supposed to have been invented about the time of the council of Nice (325); but the first year of the first cycle is placed by chronologists nine years before the commencement of the Christian era. Hence the year of the cycle corresponding to any given year in the Julian calendar is found by the following rule: *Add nine to the date, and divide the sum by twenty-eight; the quotient is the number of cycles elapsed, and the remainder is the year of the cycle.* Should there be no remainder, the proposed year is the twenty-eighth, or last of the cycle. In the reformed calendar this rule can only apply from century to century; for the order is interrupted by the omission of the intercalary day every hundredth year, and is not restored till the end of four hundred years. [DOMINICAL LETTER.]

The *cycle of the moon* is a period of nineteen solar years, after which the new and full moons fall on the same days of the year as they did nineteen years before. This cycle was invented by Meton, an Athenian astronomer, and the chronological period which he founded on it is celebrated in history under the name of the *Metonic cycle*. The Metonic cycle contained exactly 6,940 days, which exceeds the true length of nineteen solar years by nine and a half hours nearly. On the other hand, it exceeds the length of 235 lunations, or synodic revolutions of the moon, by seven hours and a half only. The framers of the ecclesiastical calendar, in adopting this period, altered the distribution of the lunar months, in order to accommodate them to the Julian intercalation; and the effect of the alteration was that every three periods of 6,940 days was followed by one of 6,939. The mean length of the cycle was therefore 6,939¾ days, which agrees exactly with nineteen Julian years. A table, therefore, showing the days of the new and full moons for nineteen years, would serve to show the days of these phenomena for any year whatever when its number in the cycle is known. The number of the year in the cycle is called the *golden number*; either because it was so termed by the Greeks, who, on account of its utility, ordered it to be inscribed in letters of gold in their temples, or more probably because it was usual to distinguish it by red letters in the calendar. The cycle is supposed to commence with the year in which the new moon falls on the 1st of January. This happened in the year preceding the commencement of our era; hence to find the number of any year in the lunar cycle, or the golden number of that year, we have this rule: *Add one to the date, and divide by nineteen; the quotient is the number of cycles elapsed, and the remainder is the year of the cycle.* Should there be no remainder, the proposed year is the last or nineteenth of the cycle.

Cycle of indictions, or *Roman indiction*, a period of fifteen years; not astronomical, like the two former, but entirely arbitrary. Its origin and the purpose for which it was established are alike uncertain; but it is conjectured that it was introduced by Constantine the Great, about the year 312 of the common era, and had reference to certain judicial acts that took place under the Greek emperors at stated intervals of fifteen years. In chronological reckoning, it is considered as having commenced on the 1st of January of the year 313. By extending it backwards to the beginning of the era, it will be found that the first year of the era corresponded with the fourth of the cycle. In order, therefore, to find the number of any year in the cycle of indiction, we have this rule: *Add three to the date; divide the sum by fifteen, and the remainder is the year of indiction.* [CALENDAR.]

Cyclic Chorus. The chorus which performed the songs and dances of the Dithyrambic Odes at Athens. They derived their name from the circumstance of their dancing round the altar of Dionysus (Bacchus) in a circle (*κυκλός*), and were thus distinguished from the square (*τετραγωνος*) choruses of tragedy.

Cyclic Planes of a Cone. The two planes, through one of the axes, which are parallel to the planes of circular section of the cone. The equation of a cone being thrown into the form

$$x^2+y^2+z^2=\lambda \text{ L M},$$

L = 0 and M = 0 will obviously be the equations of its cyclic planes, and by attributing to the parameter λ all possible values the above equation will represent a system of concylic cones. [CONCYCLIC QUADRICS.] The perpendiculars to the cyclic planes through the vertex are the *focal lines* of the reciprocal cone. [FOCAL LINES.] A sphere around the vertex of the cone is cut by the latter, its cyclic planes, and its focal lines respectively in a *sphero-conic*, its *cyclic arcs*, and its *foci*, and thus the reciprocal properties of cyclic planes and focal lines give rise to properties of sphero-conics which are in many respects precisely similar to those of plane conics. [SPHERO-CONICS.]

Cyclic Poets. The vast number of poems, which treated of the mythological and heroic ages of Greece, rendered some arrangement in the order of reading them absolutely necessary. Thus, besides the *Iliad* and *Odyssey* of Homer, there were five other epic poems relating to the legend of Troy alone, two giving the adventures of Heracles, with many others which are now known only by name. These poems were arranged at Alexandria, in the second century B.C., not according to merit, but simply by the order of the events which they professed to narrate; and the whole collection received the name of the Epic Cycle. This cycle comprised the Homeric poems as well as all others; but, inasmuch as the former were generally spoken of by themselves, the phrase *cyclic poet* came gradually to express inferiority. (Grote's *History of Greece*, part i. ch. xxi.)

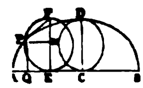
Cyclical Permutation. [PERMUTATIONS.]

Cyclifying Line, Plane and Surface. The developable surface which contains a given non-plane curve, and which on being unfolded transforms that curve into a circular arc of a given radius, is called the *cyclifying surface* corresponding to that radius. Its tangent planes are the *cyclifying planes* of the curve, and its generators the *cyclifying lines*. The theory of cyclifying surfaces possesses considerable interest, being obviously a generalisation of that of the rectifying surface, which latter in fact is a cyclifying surface corresponding to the radius infinity. The developable osculatrix of a common helix, or more generally of any curve with constant radius of curvature, is clearly a cyclifying surface. The subject has been investigated to some extent by Molins. (Liouville's *Journal*, s. 2, tom. i.; and Schell, *Allgemeine Theorie der Curven doppelter Krümmung*, Leipzig 1859.)

Cyclobranchians, Cyclobranchiata (Gr. κυκλός, and βράγχια, *gills*). The name of an order of hermaphrodite Gastropodous Molluscs, including those in which the branchiæ consist of little tufts or pyramids attached in a circular arrangement to the inner surface of the margin of the mantle.

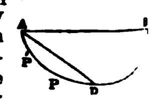
Cyclograph. [ARCOGRAPH.]

Cycloid or **Trochoid** (Gr. κυκλοειδής, and τροχοειδής, *like a circle* or *wheel*). In Geometry, one of the transcendental curves, described by a point P in the circumference of a circle which rolls along an extended straight line A B until it has completed a revolution. Some of the properties of the curve are obvious from this definition. The line A B, which is called the *base* of the cycloid, is equal to the circumference $2r\pi$ of the generating circle; and C D, which is the axis of the cycloid, is equal to the diameter $2r$. In any position EPF of the generating circle,



$$\text{A E} = \text{arc EP} = r\phi,$$
$$\text{A Q} = x = \text{A E} - \text{P R} = r(\phi - \sin\phi),$$
$$\text{P Q} = y = r(1-\cos\phi).$$

It is also easy to prove that the whole length of the cycloid A D B is equal to four times C D, and the whole area or space between the curve and its base three times that of the generating circle. A portion of the curve D P, counted from its summit, is double of F P, the supplemental chord of the arc E P; and F P is also a tangent to the cycloid at P. The curve has many other remarkable properties which have been discovered by more recondite investigations. Its *involute*, or the curve formed by unfolding a thread or flexible line A P D, fixed at A, is a semicycloid equal and similar to A P D. If a heavy body slide, without friction, down the arc of an inverted cycloid, it will arrive at the lowest point D in precisely the same time, no matter whether it start from P, P′ or A. This property of the cycloid is termed *isochronism*. If a body is to descend by the force of gravity from a point A to another point D not in the same vertical line, it will accomplish the passage in a less time by describing the cycloid A P D than by moving in the straight line A D, or in any other path whatever. [BRACHISTOCHRONE.]



The cycloid may be made to assume an endless variety of forms by placing the tracing point not in the circumference of the generating circle, but without or within it, though still in the same plane. When the tracing point is without the circle, the curve has its base shortened, and is called the *curtate* or *contracted cycloid*. If the point is within the circumference, the curve is called the *prolate* or *inflected cycloid*.

Few curves have afforded finer scope for the exercise of modern geometry than the cycloid. Its properties successively engaged the attention of Roberval, Fermat, Descartes, Pascal, Slusius, Wren, and Wallis. Huygens rectified the curve so early as 1657; and having afterwards discovered its isochronism, he applied these discoveries to the improvement of the pendulum, and showed how a perfectly syn-

chronous vibration could be procured, theoretically at least, by causing a flexible rod to vibrate between cycloidal cheeks. Its property of being the line of swiftest descent was discovered by John Bernoulli in 1697.

Cycloid, Companion to the. This name was given by Roberval (*Mémoires de l'Académie Royale des Sciences*, tome iv. 1730) to a certain curve, intimately connected with the cycloid, by means of whose properties he succeeded, in 1634, in solving the problem of the quadrature of the cycloid which had been proposed to him six years previously by Mersenne. The curve in question may be conceived to be generated by a point M [CYCLOID] which always remains vertically over the point of contact E of the rolling circle and its base A B, and in the same horizontal line as the describing point P. The companion to the cycloid obviously bisects the rectangle on A B and CD, so that its area is equal to twice that of the rolling circle. On the other hand it can be easily shown that the area of the space between the cycloid and its companion is precisely equal to that of the rolling circle, so that the area of the cycloid itself is three times that of the circle.

Cycloides (Gr. κυκλοειδής, *circular*). A name given by Agassiz to one of his orders of Fishes, the species composing which have scales composed of simple layers with smooth margins, but often ornamented on their exterior surface with different figures impressed upon all the layers, which are of horn or bone without enamel. The scales of the lateral line, instead of being flat, are funnel-shaped; the contracted part applied against the disc of the scale forms the tube by which the mucus exudes which covers the fish. The families included in the *Cycloid* order are: *Labroides*, *Mugei*, *Atherini*, *Scomberoides*, *Gadoides*, *Gobioides*, *Muraenoids*, *Lucioides*, *Salmonoides*, *Clupeoides*, and *Cyprinoides*.

Cyclones (Gr. κυκλός). Rotatory storms or whirlwinds, occurring in the tropical seas of China, the West Indies, and round Mauritius, but never on the equator. Their diameter is generally about 200 or 300 miles, but sometimes exceeds even 500. The centre of the vortex (which is always calm) travels at a rate varying from two to thirty miles an hour. These storms are preceded by a singular stillness of atmosphere, and a rapid fall of the barometer. They are perhaps the most destructive of all storms.

Cyclopaedia or **Encyclopaedia** (Gr. ἐγκυκλοπαιδεία, from the words ἐγκύκλιος παιδεία, the circle of arts and sciences gone through in Greek education). A work containing definitions or accounts of the principal subjects in one or all departments of learning, art, or science. Its arrangement may be either according to divisions into the various sciences, &c., or the subjects may be arranged and treated in alphabetical order. The *Encyclopédie Française*, or *Dictionnaire Encyclopédique*, and the *Encyclopædia Britannica*, have been the most celebrated works of this species; but the earliest appears to be the *Lexicon Technicum* of Harris, published in 1706. The great French work, the *Encyclopédie Méthodique*, consists, not of one, but of a series of encyclopædias or dictionaries. [DICTIONARY; ENCYCLOPÆDIA.]

Cyclopean. A term applied to certain huge structures the remains of which are found in many parts of Greece, Italy, and Asia Minor, the architecture of which was totally different from that which prevailed in the historical ages. The epithet originated in the Grecian tradition that assigned these buildings to the gigantic strength of the Cyclopes. They are distinguished by the irregular character of the masonry and the large dimensions of the stones, which are laid without any mortar.

Cyclopeïte. [BREISLAKITE.]

Cyclopes (Gr. κύκλωψ). In Mythology, a race of gigantic beings represented by the later poets as dwelling in Sicily, where they assisted Hephæstus or Vulcan in forging the thunderbolts of Jupiter. They had only one eye, round, and situated in the centre of the forehead. The most celebrated among them was Polyphemus, a son of Poseidon, the god of the sea. The ninth book of the *Odyssey* relates his discomfiture by Odysseus (Ulysses).

Cyclopite. A hydrated silicate of alumina and lime with minor proportions of peroxide of iron, magnesia, soda and potash. It occurs in the dolerite of the Cyclopean Islands in small, white and transparent crystals with a vitreous lustre.

Cyclosis (Gr. κύκλωσις). A term applied by Schultz to that general motion of latex or the vital fluids of plants, which passes through vessels of a peculiar kind, and which is diffused through the system of plants without interruption; in distinction to *rotation*, or the movement of fluids in separate cells, as in *Chara*, *Vallisneria*, &c. According to this physiologist, the phenomenon of cyclosis is confined to the highest forms of vegetation, while that of rotation is characteristic of the more imperfect orders of plants.

Cyclostoma (Gr. κυκλός, and στόμα, *a mouth*). A genus of air-breathing Gastropods or snails; so called on account of the circular form of the aperture of the shell. *Cyclostoma elegans* and *Cyclostoma productum* are both natives of England.

Cyclostomes, Cyclostoma. A tribe of cartilaginous fishes, including those in which the mouth is surrounded by a circular lip, forming a large sucker, as in the lamprey.

Cydonia (from Cydon, in Candia, its native place). The Quince, *C. vulgaris*, is the principal member of this genus of *Pomaceæ*, which is distinguished from *Pyrus* by the leafy calyx lobes, and the many-seeded cells of its fruit. The Quince is a well-known hardy deciduous tree, cultivated for its austere fruit, which, however, is turned to good account by cooks and confectioners.

Cygnus (Lat. *the swan*). In Astronomy, one of the old constellations in the northern hemisphere.

CYGNUS. In Ornithology. [SWAN.]

Cylinder (Gr. *κύλινδρος*, from *κυλίνδω*, *I roll*). In Architecture, a system of executing foundations has been lately introduced, in which cylinders of iron are employed, and the interior of the cylinder is then excavated to the depth that may be required and the space filled in with concrete. The descent of the cylinder may be effected in various ways, either by pneumatical pressure, or by direct impact after the ground in the interior has been removed. The bridges at Rochester, Saltash, Strasburg, Theiss &c. were founded in this manner, which is becoming very fashionable amongst our engineers.

CYLINDER. In Geometry, a solid which may be conceived to be formed by the revolution of a rectangular parallelogram about one of its sides. The surface of a cylinder, not including the two ends, is equal to the rectangle formed by multiplying the circumference of its base into its altitude; and the solid content is equal to its altitude multiplied into the area of its base. A sphere, and the cylinder circumscribed to it, have a remarkably simple relation to each other, first discovered by Archimedes, their volumes being as 2 : 3.

The above definition of a cylinder is that given by Euclid; the term is now used, however, to denote, generally, the *surface* generated by a right line moving parallel to itself. Cylinders are distinguished according to the nature of their plane sections or, like all other surfaces, according to their *orders*. The plane sections of cylinders of the second order may be any of the conic sections: we have thus *elliptic*, *hyperbolic* and *parabolic* cylinders amongst quadric surfaces. If the section perpendicular to a generator be a circle, the cylinder is said to be a *right cylinder*, and is the one defined by Euclid. If such a section be an ellipse, there will always be two others, equally inclined to the generators, which will be circular [CYCLIC PLANES], and, considering either of these cyclic planes as the base, the cylinder is said to be *oblique*. All cylinders are cut by parallel planes in equal and similar curves.

Cylindrical Boiler. A boiler made entirely in the shape of a cylinder is known under this name. It is simple in its construction, and admits of greater resistance to the lateral action of the causes of displacement than most others; but it is the most expensive on the score of the fuel needed to raise the heat. In fact, the fire is made beneath the cylinder, and has therefore to boil the water mainly by the passage of the heat through the body it contains.

Cylindro-conical. In Gunnery, a term applied to a shot the body of which is cylindrical, and the head conical in form.

CYLINDRO-CONOIDAL SHOT have conoidal heads: of this form are the service shot in use with Armstrong rifled guns.

CYLINDRO-OGIVAL SHOT have ogival heads. This form of head has been found, by recent experiments, to offer the least resistance to the atmosphere, and consequently to lose less velocity during flight than any other.

Cylindroid (Gr. *κυλινδροειδής*). A solid which differs from a cylinder in having ellipses instead of circles for its ends or bases. The term is now rarely used.

Cyma (Gr. *κῦμα*, *a wave*). In Architecture, a name applied to a moulding deriving its name from its contour resembling that of a wave, being hollow in its upper part and swelling below. Of this moulding there are two sorts; the *cyma recta*, just described, and the *cyma reversa*, whose upper part swells, whilst the lower is hollow. By the workmen these are called *ogees*.

Cymbals (Gr. *κύμβαλον*, from *κύμβος*, *a hollow*). Brass musical instruments of percussion, played in pairs by striking one against the other. They are circular, about six or eight inches diameter, attached to leather mountings, by which they are held. Cymbals are of great antiquity. They were employed by the Greeks in the festivals of Cybele and Bacchus.

Cymbium (Lat.; Gr. *κυμβίον*, *a small cup*). In Natural History, a name given by many writers to a kind of sea-shell, commonly called the *gondola*. It belongs to the family *Volutidæ*. The *Cymbium melo* often attains a gigantic size.

Cyme (Gr. *κῦμα*, *a sprout*). In Botany, a form of inflorescence consisting of a solitary flower seated in the axils of dichotomous ramifications, as in *Sambucus*. This term is also sometimes improperly used, in place of *coma*, to express the head of a forest-tree.

Cymol. A hydrocarbon, contained in the volatile oil of cumin $= C_{10}H_{14}$.

Cymophane (Gr. *κῦμα*, *a wave*, and *φαίνομαι*, *I appear*). The name given to those semi-transparent varieties of Chrysoberyl which display a peculiar milky or opalescent appearance. [CHRYSOBERYL.]

Cynapia, Cynapine. An alkaloid said to exist in Fool's Parsley (*Æthusa Cynapium*).

Cynaraceæ (Cynara, one of the genera). In Botany, one of the divisions of the great group of *Compositæ*, admitted by Jussieu. It contains the thistle, the artichoke, and similar plants, which have their capitula surrounded by a hard spiny or lacerated involucrum, and long equal tubular florets with an inflated limb. They are also called *Cynarocephalæ*.

Cynarrhodium. In Botany, a fruit with distinct ovaries, and hard indehiscent pericarps enclosed within the fleshy tube of the calyx, as in *Rosa*.

Cynics. A sect of philosophers among the Greeks, so called from their snarling humour and their disregard of the conventional usages of society; the name being derived from *κύων*, *a dog*. It is difficult to give any satisfactory account of the tenets of this sect, as during all the period of its existence it was in a state of constant fluctuation. Its professed aim was to inculcate the love of rigid virtue and a contempt of pleasure. On this point the testimony of Horace—himself a zealous adherent of the school of Aristippus, the very opposite of the

cynical sect—even were there no other, must be held to be conclusive; and, according to his opinion, the aim of the cynical philosophy was to induce every man to become

Virtutis verae custos, rigidusque satelles.

This sect, to which Diogenes belonged, was founded by Antisthenes, a disciple of Socrates, who sought to imitate his master in disregard of outward splendour and contempt of riches; but his indifference to these things soon degenerated into an ostentatious display of poverty.

Cynips. A Linnæan genus of Hymenopterous insects, belonging to that section which has not a poisonous sting. The ova of this genus are deposited in living trees, and the irritation excited by their presence gives rise to the formation of the excrescences called *galls*.

Cynodin. A crystalline matter found in Dog-grass (*Cynodon dactylon*).

Cynomoriaceæ (Cynomorium, one of the genera). In Botany, a group of Rhizanths now included in *Balanophoraceæ*. One species, *Cynomorium coccineum*, is a native of Malta, and was formerly supposed to possess great medicinal powers as an astringent: it figures in old officinal catalogues under the name of *Fungus melitensis*.

Cynosarges (Gr. κυνόσαργες). A sort of academy in the suburbs of Athens, situated near the Lyceum: so called from the mythological story of a white dog (κύνος ἀργοῦ), which, when Diomus was sacrificing to Hercules, carried off part of the victim. Besides possessing several temples erected in honour of Hercules, Alcmene, and other gods, it was chiefly famed for its gymnasium, in which foreigners or citizens of half-blood used to perform their exercises; and as being the place where Antisthenes instituted the sect of the cynics, and taught his opinions.

Cynosure (Gr. κυνόσουρα). Literally, the tail of a dog, applied by some philosophers to the constellation Ursa Minor: whence it has been borrowed by the language of poetry, in which it signifies 'a point of attraction:'

Where perhaps some beauty lies,
The cynosure of neighbouring eyes.—*L'Allegro*, 79.

Cynthius and Cynthia. In Mythology, surnames given by the ancient poets to Apollo and Artemis; from Cynthus, a mountain of the island of Delos, on which they are said to have been born.

Cynurenic Acid. A crystalline acid found in the urine of the dog. It differs from uric acid in being soluble in hydrochloric acid.

Cyperaceæ (Cyperus, one of the genera). A natural order of Endogens, inhabiting the marshes, ditches, streams, &c. of all countries. They closely resemble *Graminaceæ*; but are distinguished from them by the stems being solid and angular, not round and fistular, and by there being no diaphragms at the articulations. They approach *Juncaceæ* and *Restiaceæ*, but are known at once by the sheaths of their leaves not being split. Their sensible properties are unimportant. *Carex arenaria* affords one of the European substitutes for sarsaparilla.

Cyphellæ. A term used in describing lichens, to denote pale tubercle-like spots on the under surface of the thallus.

Cypher. In Diplomatic affairs, 'an occult manner of writing, legible to those only who possess the key or secret.' This art, in a variety of forms, has been more or less practised in every civilised country; and has been cultivated by the moderns in particular to such a degree as to have acquired the importance of a distinct science, under the names *Cryptography, Polygraphy, Stenography*, &c.

Cyphonism (Gr. κυφωνισμός, from κύφων, *a piece of bent wood*). A species of punishment, which consisted in besmearing the criminal with honey, and then exposing him to insects. This punishment was carried into effect in various ways, but chiefly by fastening the sufferer to a stake, or extending him on the ground with his arms pinioned.

Cypræa. The name of a Linnæan genus of the *Vermes Testacea*, characterised by a subovate smooth shell, with a linear aperture extending from one end of the shell to the other, and transversely furrowed or dentated in the mature state. The genus is retained without subdivision, and forms part of the *Buccinoid* family of the Pectinibranchiate order of Gastropods of the system of Cuvier.

This genus is remarkable for the difference of form which exists in the young and old states of the shell: in the former the lip is thin, and the aperture wide, but the mantle is progressively developed until its lobes extend over the columella on the one side and the lip on the opposite side of the aperture, covering them with successive layers of nacreous shell, and at length diminishing the aperture to a narrow linear form. [COWRY.]

Cyprine. A blue variety of Idocrase, found near Tellemarken in Norway. The colour is supposed to be caused by copper.

Cyprinus (Lat.). A Linnæan genus of abdominal fishes, now the type of a family of Malacopterygians in the system of Cuvier, and of Cycloid fishes in the system of Agassiz; including the genus *Cyprinus* proper, or carps; *Barbus*, or barbels; *Gobio*, or gudgeons; *Tinca*, tenches; *Abrama*, breams; *Leuciscus*, minnows; *Cirrhinus*; *Labes*; *Catastomus*; and *Gonorhynchus*.

Cypsela (Gr. κυψέλη, *a chest*). In Botany, a one-seeded, one-celled, indehiscent fruit, with the integuments of the seed not cohering with the endocarp: in the ovarium state evincing its compound nature by the presence of two or more stigmata, but nevertheless unilocular, and having but one ovule. Usually called an Achene or Achenium.

Cyrenians. The philosophers of a school founded at Cyrene, a Grecian colony on the northern coast of Africa, by Aristippus, a disciple of Socrates. They held, with the Epicureans, that pleasure was the only good and pain the only evil, and were not at such pains as the latter to prove that the first could only attend on virtuous conduct; they also

differed from them in not considering absence from pain of itself to be a pleasure of the highest order. Perhaps the most favourable view of the philosophy of this sect is to be obtained from the Satires and Epistles of Horace, in which the versatility of disposition, politeness of manners, and knowledge of the world that distinguished the Cyrenians, are set forth with great clearness, and with all the ardour of an enthusiastic disciple. The grand principles of Aristippus are thus described in the couplet—

> Omnis Aristippum decuit color et status et res,
> Tentantem majora, fere præsentibus æquum:

and the poet's own partiality for this system of philosophy, and its accommodating character, are thus exhibited:—

> Nunc in Aristippi furtim præcepta relabor,
> Et mihi res non me rebus subjungere conor.

Cyrillaceæ (Cyrilla, one of the genera). A small order of hypogynous Exogens, belonging to the Berberal alliance, and consisting of shrubs with regular symmetrical flowers having an imbricated corolla; the stamens alternating with the petals; axile placentæ; and pendulous ovules. They are of little interest.

Cyrtandraceæ (Gr. κυρτός, *crooked*, and ἀνήρ, *a male*; Cyrtandra, the name of one of the genera). A natural order of monopetalous dicarpous Exogens, inhabiting the tropics, and closely allied to *Gesneraceæ*, *Bignoniaceæ*, and *Pedaliaceæ*; differing from the former only in never producing an inferior ovary, in their deeply lobed placentæ, their siliquose fruit, and the want of albumen; from *Bignoniaceæ*, by their habit, their minute apterous seeds, and one-celled ovary, with two double parietal placentæ; from *Pedaliaceæ*, in nothing except their minute indefinite seeds, and the membranous texture of the fruit and placentæ.

Cystibranchians, Cystibranchia (Gr. κύστις, *the bladder*, and βράγχια, *gills*). A family of Isopodous *Crustaceæ*, comprehending those which have the branchiæ lodged in vesicular cavities.

Cystics, Cystica (Gr. κύστις). Rudolphi thus denominates the order of Entozoa in which the body is terminated by a cyst peculiar to one individual or common to many. The hydatid in the brain of sheep, and the parasite which produces measly pork, are examples of this order.

Cystine. A term applied to the *cystic oxide*, a constituent of certain urinary calculi. Its chemical formula is $C_6 H_6 O_4 N S$. It is sometimes voided in the form of a yellowish crystalline sand.

Cystitis (Gr. κύστις). Inflammation of the bladder.

Cystocele (Gr. κύστις, and κήλη, *a tumour*). A hernia or rupture formed by a protrusion of the bladder.

Cystotomy (Gr. κύστις, and τέμνω, *I cut*). The operation of cutting into the bladder for the extraction of a stone or other extraneous substance.

Cytheræa (Lat.; Gr. Κυθέρεια). In Mythology, a name given to Aphrodite (Venus), from the island Cythera, where she had a well-known temple.

Cytinaceæ (Cytina, one of the genera). In Botany, a natural order of Rhizanths inhabiting the south of Europe, the Cape, and Guinea. They are very little known, and have no sensible properties of importance. Pelletier says that *Cytinus* has the property of precipitating gelatin without containing tannin.

Cytisine. A purgative bitter principle extracted from the *Cytisus alpinus*. The poisonous principle of the *Cytisus Laburnum*.

Cytisus (Lat.; Gr. κύτισος). This plant, frequently mentioned in Greek and Latin writers, is generally supposed to be a kind of clover, the *Medicago arborea* of Linnæus.

Cytoblast (formed from Gr. κύω, *I hold*, and βλαστός, *a sprout*). In Physiology, the nucleated cellule, or centre of assimilative force, from which the organic cell is developed.

Cytoblastema. The structureless substance in which the elementary nuclei, cellules, or cytoblasts, are embedded.

Czar, Zar or **Tsar.** A title given to their monarch by several Slavonic tribes. In Russia, Ivan II. adopted in 1579 the title of Czar of Moscow. The eldest son of the czar was termed Czarovicz; but after the death of Alexis, the murdered son of Peter I., this title was no more used, until revived by Paul I., in 1799, in favour of his second son, the late grand duke Constantine. The consort of the emperor of Russia is styled *Czarina*.

D

D. The fourth letter in the Hebrew alphabet and those derived from it, is the medial of the order of dentals or palato-dentals; and is susceptible of various interchanges, particularly in the German and English languages. As an abbreviation, D has several significations; thus, M.D. Doctor of Medicine; D.D. Doctor of Divinity, &c. Among Roman writers, D. is used for Divus, Decimus, Devotus, Diebus, &c. D.M. in the Roman epitaphs signifies Diis Manibus, Deo Magno, or Diis Magnis. As a Roman numeral, D signifies five hundred: in this case, it is more correct to write IↃ.

D. In Music, one of the notes of the scale, corresponding to the French *Re*.

Da Capo (Ital.). In Music, usually written short, D.C. An instruction to the performer in such airs as end with the first strain, that the

song must be begun again and ended with the first part.

Dab. [PLEURONECTES.]

Dace. [CYPRINUS LEUCISCUS.]

Dacelo. One of those generic terms which Dr. Leach framed by transposing the letters of the name of the typical or Linnæan genus from which the species so designated were dismembered; in the present case, the word is obtained from *Alcedo*, and is applied to a large Australian species of Passerine bird, nearly allied to the kingfisher.

Dacrydium. [DIAGRIDIUM.]

Dacryoma (Gr. δακρύω, *I weep*). A disease of the lachrymal duct of the eye, by which the tears are prevented passing into the nose, and therefore trickle over the face.

Dactyl (Gr. δάκτυλος, *the finger*). The name of a metrical foot in Greek and Latin poetry, consisting of a long and two short syllables; as in the word *cārmĭnă*. In the English and German languages, where accent determines quantity, the word *dactyl* means an accented followed by two unaccented syllables; as in *quantity, liebliche*.

Dactyli (Gr. δάκτυλοι). A name given to the Phrygian priests who were connected with the worship of Rhea or Cybele, and are identified or confused with the Corybantes, Curetes, and Cabiri. [CABIRI.]

Dactyliograph (Gr. δακτύλιος, *a ring*, and γράφω, *to engrave*). In ancient Gem Sculpture, the inscription of the name of the artist on a gem.

Dactyliography (Gr. δακτύλιος, and γράφω, *to write*). In Gem Sculpture, the science of gem engraving.

Dactylology (Gr. δάκτυλος, *a finger*, and λόγος). The art of spelling words by placing the fingers in such positions as to signify the letters of the alphabet.

Dactylopterous (Gr. δάκτυλος, and πτερόν, *a wing or fin*; *finger-finned*). A fish is said to be dactylopterous when the inferior rays of its pectoral fin are partially or entirely free. The term *Dactylopterous* has been applied by Lacepède to a genus of Gurnards, remarkable for the great expansion of their pectoral fins. The most common and best known species of this genus inhabits the Mediterranean, and is the *Trigla volitans* of Linnæus, or the flying gurnard. It is sometimes confounded with the true flying fish (*Exocœtus*).

Dado (Ital.). In Architecture, the die, or that part of a pedestal, in the middle between the base and the cornice; it takes its name from being a cube like a die. The term is also applied to the wainscoating of a room which would be supposed to represent the *dado* of the pilasters arranged round it.

Dadyl (Gr. δᾳδίον, *a torch*). A hydrocarbon derived from oil of turpentine.

Dædalus (Gr. Δαίδαλος). In Mythology. A son or grandson of Erechtheus, king of Athens, who fled to Crete, and there built the labyrinth for the Minotaur. Being afterwards imprisoned in it himself, he with his son Icarus escaped by wings which he made. The latter fell into the strait which bears his name, while Dædalus safely reached Sicily. The epithet *Dædalean* is applied by Homer to works wrought in wood or metal, but not of embroidery. (Grote, *History of Greece*, part i. ch. xii.)

Dæmon. [DEMON.]

Dæmonomania. The species of madness or melancholy in which the patient supposes himself to be possessed of devils.

Dagger (Fr. dague, Ital. daga). A short sword or long knife. This weapon was in use among the Franks as early as the sixth century. In the twelfth century it is mentioned as a '*cultellus* qui dicitur *dagger*,' and Walsingham in the fifteenth century calls it '*coustel* or *dagger*.' Towards the close of the thirteenth century it was used as part of the knightly equipment, and about this time it was called the *misericorde*, because in the last struggle the uplifted dagger caused the discomfited fighter to sue for mercy. Towards the end of the fourteenth century, knights always wore a dagger suspended by a cord or chain to the right side, and it was even sometimes used as a missile weapon. At this time it was carried by citizens, yeomen, sailors, and even ladies. It still remains in the midshipman's dirk. (Hewitt's *Ancient Armour and Weapons in Europe*.)

DAGGER. In Printing, a character marked thus †, used as a reference to notes in the margin of the page. It is also called an *obelisk*.

Dagon (Heb. דָּג, dag, *a fish*). One of the principal divinities of the ancient Phœnicians and Syrians, and more especially of the Philistines, represented as half man and half fish. (Judges xvi. and 1 Samuel v.)

Daguerreotype. The name given to a process introduced by Daguerre, by which the images from the lens of a camera obscura are transferred to metal plates. The sensitive surface of the plate is a film of iodide of silver, upon which the images are rendered apparent by exposure to the vapour of mercury. This curious and ingenious process has been almost entirely superseded by other photographic processes. [PHOTOGRAPHY.]

Dahlia (after Andrew Dahl, a Swedish botanist). The name of a Mexican genus of *Compositæ*, which has yielded one of our most popular autumnal garden flowers, although originally introduced in consequence of the eatable character of the roots, which somewhat resemble a bad potato. The original dahlias bore flower-heads with a single outer row or ray of large coloured florets, and a disc or centre of smaller yellow tubular ones; but the varieties have been year by year improved under the hands of the florists, until the yellow-disc florets have been replaced by others similar to those of the ray, the whole being at the same time so modified in shape that the 'blooms' become models of symmetry.

Dahlin. [INULIN.]

Daimio. The title of the feudal lords of Japan. The Daimios are 264 in number, and exercise in their own districts the powers of

petty sovereigns. Eighteen of these princes are virtually independent within their own dominions; and hence arise many impediments in the way of that intercourse with Europeans which the Tycoon, or temporal sovereign of Japan, seems willing to promote.

Dairy (Old English, dey, *a servant in husbandry who made cheese and butter*; Swed. deja, *a dairymaid*). An apartment in a house, or a separate building, for the purpose of holding milk, and manufacturing it into butter, cheese, or other dairy produce. On a small scale, where butter only is made from milk, the dairy may be a room in the north side of the dwelling-house; or it may form one of the offices connected with the kitchen court. The requisites for the room to contain the milk are—an equal temperature throughout the year, viz. between 48° and 55°; sufficient ventilation to carry off all bad smells and impurities in the air; and the exclusion of flies and other insects. An equable temperature is maintained by thick or by hollow walls, and by double windows. In winter the temperature is somewhat raised by the warm milk, and in summer it is cooled to the degree required by ventilation and the evaporation of water poured on the floor. The ventilation is effected by opening the glazed sashes of the windows, and supplying their places by wire shutters; and indeed one of the best modes of arranging the windows of a dairy is to have wooden shutters outside for closing in the most severe weather in winter; next, a fixed frame of wirework to exclude the flies; and within this, at three or four inches' distance, the glazed sash, which should be made to open. A dairy on a large scale is most conveniently arranged as a detached building; in which case, it contains a milk-room, a churning-room, and a dairy scullery, or place for scalding the utensils. If cheese is to be made, a room will be required for the cheese press, and another for drying the cheeses.

The quantity of milk raised in the vicinity of London for the supply of the inhabitants, and the revenue derived from the sale of it, show the importance of this article. In his valuable work on cattle, their breeds, &c. Mr. Youatt estimates the number of dairy-cows at present kept in London and its environs at 12,000; affording, on Mr. Middleton's hypothesis, an annual supply of 38,400,000 quarts of milk. Now, as milk is sold by the retailers at from 3*d.* to 4*d.* a quart, after the cream is separated from it, and as the cream is usually sold at from 2*s.* 6*d.* to 3*s.* a quart, and there is reason to suspect that a good deal of water is intermixed with the milk, we should hardly be warranted in estimating that the milk, as obtained from the cow, is sold at less than 5*d.* a quart, which gives 800,000*l.* as the total price of the milk consumed in the city and its immediate vicinity. (M'Culloch's *Statistics*, 2nd ed. vol. i. p. 490.)

Dais. In Architecture, the platform, or raised floor, at the upper end of a dining hall where the table intended for the principal guests stood; also the seat, with a canopy over it, for those who sat at the high table.

Dalbergia (after Nicholas Dalberg, a Swedish botanist). A genus of large tropical Eastern forest trees of the Leguminous order, yielding some most valuable timbers. The Blackwood, or East Indian Rosewood, is the timber of *D. latifolia*; and *D. Sissoo* furnishes the Sissum wood, which is much employed for purposes where hard durable wood is required. They have mostly pinnate leaves and racemose flowers, while the pods are either long, thin, and straight, or short and crescent-shaped.

D'Alembert's Principle. An important theorem first enunciated by D'Alembert in a memoir communicated to the Academy of Paris in 1742, and by means of which dynamical problems are reduced to statical ones. It may be thus explained: The particles of a rigid body being invariably connected with each other are not free to accept the motions impressed upon them by the action of externally applied forces; in other words, the effect of such forces must consist of the actual or *expressed* motions of the particles, and of certain internal strains or pressures which are overcome by the rigidity of the body. Now whatever may be the magnitude or nature of these internal strains, it is obvious that equilibrium would result if we were to oppose the given applied forces by a system of new forces, applied to the several particles of the body, and capable of imparting to each particle, considered as isolated and perfectly free, a velocity precisely equal and opposite to that which it actually receives under the action of the given forces. To express this condition mathematically, let x, y, z denote the coordinates of any particle whose mass is m, and let X, Y, Z be the components of the known force applied to it. Then t being the time,

$$\frac{dx}{dt}, \quad \frac{dy}{dt}, \quad \frac{dz}{dt}$$

will be the components of the *expressed* velocity of the particle, and

$$m\frac{d^2x}{dt^2}, \quad m\frac{d^2y}{dt^2}, \quad m\frac{d^2z}{dt^2}$$

the components of the force capable of giving to that particle, were it absolutely isolated from all others, precisely the same velocity. According to the principle under consideration, therefore, equilibrium must result from the simultaneous application to the body of the system of forces

$$X_1, X_2, \&c. \; -m_1\frac{d^2x_1}{dt^2}, \; -m_2\frac{d^2x_2}{dt^2}, \&c.$$

$$Y_1, Y_2, \&c. \; -m_1\frac{d^2y_1}{dt^2}, \; -m_2\frac{d^2y_2}{dt^2}, \&c.$$

$$Z_1, Z_2, \&c. \; -m_1\frac{d^2z_1}{dt^2}, \; -m_2\frac{d^2z_2}{dt^2}, \&c.$$

Expressing this condition in the ordinary manner [STATICS], we obtain the following six *equations of motion*, the fundamental ones in dynamics, in which the sign of summation extends to all particles of the system:

$$\Sigma\left(X - m\frac{d^2x}{dt^2}\right) = 0,$$

$$\Sigma\left(\mathrm{Y}-m\frac{d^2y}{dt^2}\right)=0,$$

$$\Sigma\left(\mathrm{Z}-m\frac{d^2z}{dt^2}\right)=0,$$

$$\Sigma\left\{y\left(\mathrm{Z}-m\frac{d^2z}{dt^2}\right)-z\left(\mathrm{Y}-m\frac{d^2y}{dt^2}\right)\right\}=0,$$

$$\Sigma\left\{z\left(\mathrm{X}-m\frac{d^2x}{dt^2}\right)-x\left(\mathrm{Z}-m\frac{d^2z}{dt^2}\right)\right\}=0,$$

$$\Sigma\left\{x\left(\mathrm{Y}-m\frac{d^2y}{dt^2}\right)-y\left(\mathrm{X}-m\frac{d^2x}{dt^2}\right)\right\}=0.$$

Dalmatica. A long white gown with sleeves; worn by deacons in the Roman Catholic church over the *alb* and *stole*. It was imitated from a dress originally worn in Dalmatia, and imported into Rome by the emperor Commodus, where the use of it gradually superseded the old Roman fashion of keeping the arms uncovered. A similar robe was worn by kings in the middle ages at coronations and other solemnities.

Damage-feasant (Fr. faisant, *doing*). In Law, a beast is said to be so when found in another person's ground without his leave or license; in which case the tenant may distrain or impound it; but at his own peril, if the accident have happened through his own negligence in not repairing the fences of his close. Possession, without title, is sufficient to empower the tenant to distrain damage-feasant. Proper notice is, however, to be given; and if the owner of the estate tender amends, it is unlawful to detain the beasts.

Damages (Lat. damnum, Fr. dommage, *loss*). In English Law, the recompense awarded, by a jury to a plaintiff, in certain forms of action, for the loss or *damage* he has sustained by the injury committed by the defendant. At *common law*, damages are recoverable in personal and mixed actions. In actions upon the case, trespass, &c., a certain amount of damages, sufficient to cover all the hurt really sustained by the plaintiff, is alleged or *laid* in the declaration; and it is the duty of the jury to enquire the real amount of damages, and assess it accordingly. In the action of debt, where the amount due is something certain, the damage laid is now merely nominal for the injury supposed to be done by the detention of the debt; the jury, therefore, award a nominal sum only. Damages are also allowed in actions upon a variety of statutes, and sometimes double or treble damages; in which case the plaintiff is entitled to twice or three times the amount awarded by the jury.

Damaluric Acid (Gr. δάμαλις, *a heifer*). A heavy oily liquid occurring along with *damolic acid* in cow's urine.

Damask (from *Damascus*, where it was anciently made). A woven fabric produced by a particular construction and management of the loom, in which are represented various figures of flowers, fruit, leaves, &c. The chief seat of this manufacture is Dunfermline in Fifeshire, and Lisburne and Ardoyne near Belfast. The best damasks are of linen; those of cotton are cheaper, but less elegant and durable.

Damaskening (Fr. damasquinure). The art of inlaying metals with scrollwork and other ornamentation in gold and silver, so called from Damascus, celebrated during the middle ages for the skill of its manufacturers in this class of ornamental art. In more modern times Milan has been distinguished for its damaskened armour; this decoration is very commonly applied to swords.

Damassin. A species of woven damask with gold and silver flowers.

Dame (Fr.; Ital. dama, probably a corruption of the Lat. domina, *a mistress*). Was formerly a title of honour, and is still used in the English law to denote the wife of a knight or baronet. *Dame* was also the designation of nuns of the Benedictine and certain other ancient orders.

Dammara (Dammar, its name in Amboyna). The Kaurie or Kaudi (sometimes written Cowdie) Pine of New Zealand is a species of this diœcious genus of *Coniferæ*, and is called *D. australis*. It yields a hard brittle resin like copal. *D. orientalis*, the Amboyna Pine, yields the fine transparent resin called *Dammar*. Several of the species furnish valuable timber. They have broad leathery leaves and great oblong cones.

Damourite. A species of Mica, found at Pontivy in Brittany. It is a silicate of alumina and potash; named after Damour, who first analysed it.

Damps (Ger. dampf, *vapour*). The noxious exhalations of mines and excavations. The carburetted hydrogen of coal mines is called *fire damp*; carbonic acid is termed *choke damp*.

Danaide. [Hydrodynamics.]

Danaite. A variety of arsenical pyrites, containing cobalt, found at New Hampshire, United States.

Danburite. A hydrated silicate of lime from Danbury in Connecticut.

Dancing (Ger. tanzen, *to dance*). May be defined as a graceful movement of the figure, accompanied by gestures and attitudes indicative of certain mental emotions, and by measured steps in harmony with a piece of music arranged for the purpose. The origin of all dancing is connected with religion; and the practice of it involved great labour and skill, the war dances serving as an actual preparation for war. In the ancient dancing the sexes were never mingled. When dances ceased to be religious, then it became disgraceful for Roman citizens to take part in them. Almost every country can boast of national dances peculiar to the inhabitants; which are rarely so well performed when adopted by others. Of these the best known to us are the *tarantella* of the Neapolitans, the *bolero* and *fandango* of the Spaniards, the *mazourek* and *krakovieck* of Poland, the *cosack* of Russia, the *redowac* of Bohemia, the *quadrille* and *cotillon* of France, the *waltz* and *gallopade* of Germany, and the *reel* of Scotland.

Danegelt. A tribute of twelve pence laid

by the Danes upon the Anglo-Saxons for every hide of land throughout the realm.

Dannebrog. The red cross of Denmark. The tradition is that (like Constantine) Waldemar II. of Denmark saw in 1219 in the heavens a fiery cross which betokened his victory over the Esthonians. The order of knighthood, which is supposed to have been founded in commemoration of that event, was revived in 1693, and reconstituted in 1808.

Dannemorite. A species of Hornblende from the iron mines of Dannemora in Sweden.

Dans. Small trucks or sledges used in coal mines.

Dantzic Fir. The fir timber imported from the Prussian port of Dantzic; it is generally speaking considered the best description of fir, and is usually prescribed in specifications for this reason. It can be obtained as much as 70 feet in length by about 16 inches square. The Dantzic oak is also highly esteemed.

Daphne (Gr.). A genus of *Thymelaceæ*, consisting of shrubs widely dispersed in various parts of the world. *D. Mezereum*, the Mezereon, a deciduous species found wild in woods, possesses medicinal properties, as also does the Spurge Laurel, *D. Laureola*. The fibrous bark of some of the Indian species is made into paper.

DAPHNE (Gr.). In Greek Mythology, a nymph beloved by Apollo. To escape his pursuit, she besought the aid of the Earth, which opened to receive her; and a laurel, called after her name, grew up on the spot. The name is identified with the Sanscrit Dahanâ, the Dawn.

Daphnia. A genus of the Entomostracous or lower-organised Crustaceans, belonging to the order *Branchiopoda*, and the section *Lophyropoda*. The most common species and type of this genus, *Monoculus pulex* of Linnæus, is a favourite and interesting microscopic object.

Daphnine. A crystalline non-azotised substance found in the bark of certain species of *Daphne*. It is bitter, astringent, and slightly acid. When heated, it yields a crystalline product, *Daphnetine*.

Dapico. The South American name of a species of *Caoutchouc*, obtained from the roots of *Siphonia elastica*.

Darby. A tool used by plasterers to float a ceiling; it is about 3 feet or 3 feet 6 inches long, by 7 inches in width, and has two stout handles fastened on the back, to enable the workmen to hold it.

Daric (Gr. δαρεικός). A Persian gold coin (so called by the Greeks, from Darius, the name of several Persian sovereigns), having upon the obverse an archer crowned and kneeling upon one knee, and on the reverse a quadrata incusa, or deep cleft. The weight of the daric is about 130 grains.

Daroo-tree. The *Sycomorus antiquorum*, or Egyptian sycamore or fig.

Darter. Certain web-footed birds of the Pelican family are so called. [PLOTUS.]

Dash. In Music, a small mark, thus ', denoting that the note over which it is placed is to be performed *staccato*, i.e. in a short, detached, distinct manner.

Dasyprocta (Gr. δασύπρωκτος). The subgeneric name applied by Illiger to the *Aguti* and *Acúchi*, which before were included in the great genus *Cavia* of Linnæus.

Dasypus (Gr. δασύπους, *rough-footed*). A name originally and very appropriately applied by the Greeks to the hare, but transferred by Linnæus to the genus including the Armadillos. This genus is subdivided in modern systems into *Dasypus* proper, *Tatusia*, and *Prionodon*. The remains of a gigantic extinct animal of the armadillo kind have recently been discovered in South America, and called GLYPTODON [see that word].

Dasyure (Gr. δασύς, and οὐρά, *a tail*; *hairy-tailed*). The name of a genus of Carnivorous Marsupials, comprehending those which have hairy tails combined with digitigrade feet, and a dental formula of: incisors $\frac{8}{6}$, canines $\frac{2}{2}$, prem. $\frac{4}{4}$, mol. $\frac{8}{8}$, $=42$.

Data (Lat. *things given*). The quantities or conditions which are assumed to be known in any geometrical problem. Thus in the problem, *Given the base, altitude, and area, to construct the triangle*, the data are: 1. That the figure is a triangle; 2. That it has a certain straight line for its base; 3. That its vertex is at a known distance from this base; and 4. That its area has a known magnitude. Here the data are distinguished from the *quæsitum*, which is the triangle itself; frequently, however, the term *datum* is extended to everything that is *determined* by the given conditions, magnitudes, &c. It is in this sense that Euclid understood the term in his *Book of Data*, translated by Simpson and Horsley. Marinus, one of the disciples of Proclus, wrote a preface to Euclid's *Data*, which contains a dissertation on the meaning of the term.

Date. In Diplomatics, the notation of the time and place of the delivery or subscription of an instrument. The word is derived from the common formula at the foot of instruments, 'datum,' or 'data,' *given* at such a place and time. Dates of time are distinguished into definite and indefinite. The former mark specially the year, and sometimes the month, day, &c.; the latter only contain a general reference to some period of time. Thus many instruments of the earlier part of the middle ages contained only mention of the reigning prince, without reference to the years of his reign. Definite dates are various in ancient charters and deeds. The Christian Greeks dated generally, down to the fall of Constantinople, by the year of the world; beginning their year at September 1. The date used in the oldest Latin charters is commonly that of the Indiction [INDICTION], which is also frequently added in the Greek. The Christian era (under the several names of *year of grace, of the incar-*

n of *Christ*, *of the nativity*, in common usage in royal out the reign of Hugh Portugal not until the eenth centuries. In Eng- before the Norman Conquest d by the Incarnation; but deeds s under the Plantagenet kings gene- r the year of the reigning prince.

ates. The fruit of the Date Palm (*Phœnix actilifera*). They contain from thirty to forty per cent. of sugar.

Datholite or **Datolite.** A mineral composed of silica, lime, and boracic acid; a borosilicate of lime. It occurs in Norway, in the Tyrol, and in the Harz. It becomes opaque when heated; hence the name, from Gr. δόλος, *turbid*.

Datiscaceæ (Datisca, one of the genera). A natural order of Exogens belonging to the Cucurbital alliance, and known by their apetalous flowers, parietal placentæ, and dry fruit. They occur in North America, Northern Asia, and the Eastern Archipelago.

Datiscin. A name given by Braconnot to a substance having the appearance of grape sugar, which he extracted from the *Datisca cannabina*.

Dative Case (Lat. dativus, from do, *I give*). That inflexion of a noun which denotes participation in the action of the verb which accompanies it. [GRAMMAR.]

Datura (Arab tâtórah). The Thorn-apple, a poisonous medicinal annual herb, is the most familiar example of this genus of *Solanaceæ*. It is called *D. Stramonium*, and is known by its forking stem, ovate sinuately-toothed leaves, and white funnel-shaped flowers succeeded by prickly four-valved fruit containing many black seeds.

Daturia. The poisonous principle of the *Datura Stramonium*. It belongs to the class of crystallisable alkaloids.

Daub. A rough kind of plastering, thrown, or cast, upon a wall, and also applied to the clay which is thrown upon the surface of the wattles, or sticks, in rough farm buildings.

Daucus (Gr. δαῦκον, Lat. daucum, *a carrot*). The genus of Umbellifers which contains the carrot, *D. Carota*, the succulent cultivated form of which has no doubt been produced by successive improvements, under the hands of cultivators, from the wild original, which is abundant on our coasts. Carrots are wholesome and nutritious, both as esculent vegetables, and as food for cattle.

Dauphin. The well-known title of the heir-apparent to the crown of France, before the Revolution, was that of the counts or lords of Vienne in Dauphiné, from the twelfth century, or an earlier period. In 1349, Humbert, lord of Vienne, made John, son of Philip of Valois, his heir. For some time the principality was governed by the Dauphin as a separate state, but was reunited to the crown in 1457. (Hallam's *Middle Ages*, chap. i. part ii. note k.)

Daurite. A variety of Tourmaline.

Davidsonite. A mineral discovered by Dr. Davidson in the granite quarry of Rubislaw, near Aberdeen: it is a *silicate of alumina*.

Davit. On Shipboard, a stout beam of timber, employed in hoisting the anchor. Its use is to enable the anchor to be so hauled up that the flukes shall not injure the vessel's sides. It is not fixed, but is removed from side to side as required. Davits are also projecting cranes for raising from and lowering into the water the ship's boats. They are arranged in pairs (two for each boat) along the sides and at the stern.

Davite. A name given to a fibrous sulphate of alumina found in a warm spring near Bogota, in Columbia.

Davyne. A white or brown crystallised mineral found in cavities of some of the lapideous masses ejected by Vesuvius.

Dawn. [TWILIGHT.]

Day (Ger. tag). In its most common acceptation, this word denotes the interval of time during which the sun remains above the horizon; and is opposed to *night*, which denotes the time the sun is below the horizon. In this sense it is sometimes called the *artificial day*. But the term *day* is also generally used to denote the time in which the earth makes a complete revolution with respect to the celestial bodies, and consequently expresses different intervals, according as the body with which the earth's rotation is compared is fixed or movable.

The *Astronomical* or *Solar Day*, called also the *Apparent Day*, is the time that elapses between two consecutive returns of the same terrestrial meridian to the centre of the sun. Astronomical days are not of equal length, for two reasons: 1st, the unequal velocity of the earth in its orbit, in consequence of which the apparent daily motion of the sun is greater in winter than in summer; and 2nd, the obliquity of the ecliptic, in consequence of which the sun's apparent daily motion in right ascension (that is, in the plane of the earth's equator) is less at the equinoxes than at the tropics. The astronomical day commences at noon, and is counted on through the twenty-four hours.

The *Civil Day*, or *Mean Solar Day*, is the time employed by the earth in revolving on its axis, as compared with the sun, supposed to move at a *mean* rate in its orbit, and to make 365·2425 revolutions in a mean Gregorian year. In this mode of reckoning time, the days are all of the same length; and noon, or any given hour of the civil day, sometimes precedes and sometimes comes after apparent noon, or the corresponding hour of the astronomical day. Most nations, at least in modern times, have agreed in placing the commencement and termination of the civil day at mean midnight.

The *Sidereal Day* is the time that elapses between two successive culminations of the same star. This interval of time has always within historical memory remained of the same invariable length, as is proved by the most

ancient astronomical observations. It is divided into 24 sidereal hours; and these are again subdivided into sidereal minutes and seconds. This mode of reckoning time, during the day, is now universally adopted by astronomers in their observatories. [TIME.]

Day-sight. A condition of the eye in which vision is clear in the day, but dull and confused at night. It is said to be common in some parts of Russia. In Canada it is termed *night-blindness*, and is attributed to the effect of snow on the eyes.

De Facto (Lat.). A legal phrase, denoting actual possession, however acquired; while the term *de jure* indicates a right of title which may or may not be accompanied by possession.

De Jure. [DE FACTO.]

De Luc's Column. An alternation of different substances, such as silver, zinc, and thin paper; which produce an electric arrangement. It is sometimes called the *dry pile*.

Deacon (Gr. διάκονος, *a minister* or *servant*). A minister of religion, holding, in Protestant churches, the lowest degree in holy orders. The first appointment of deacons is mentioned in Acts vi., where the Apostles direct the congregation to look out seven men of honest report, upon whom they may lay their hands. Their office at this time was chiefly the care of the poor and the distribution of the bread and wine in the love feasts; but they also had authority to preach. In the English church it is customary to require a candidate for deacon's orders to have completed his twenty-third year. He is not capable of holding any benefice, and may only officiate as a curate, chaplain, or lecturer; he may not read the Absolution, nor administer the sacrament alone, but in assisting the priest may offer the cup to the communicants. In Scotland, the term *deacon* is applied to a corporate officer.

Dead Beat. In Clockwork (called also *dead scapement*, or *scapement of repose*), a peculiar kind of scapement invented by Mr. George Graham about the year 1700, with a view to lessen the effect of the wheelwork on the motion of the pendulum; it acquired its name from the circumstance that the seconds' index stands still after each drop, whereas the index of a clock with a *recoiling* scapement is always in motion, hobbling backward and forward. [HOROLOGY.]

Dead Colour. In Painting, a colour is said to be dead when it has no gloss upon it; this is generally effected by the use of less oil and more turpentine than in ordinary paints.

Dead Ground. In Fortification, ground which cannot be seen or defended from behind the parapet of the work.

Dead Lights. Strong wooden posts or shutters put over the glass windows of the cabin in bad weather, as a defence against the sea.

Dead Nettle. [LAMIUM.]

Dead Oil. [COAL TAR.]

Dead Plate. A flat iron plate sometimes fitted before the bars of a furnace for the purpose of allowing the bituminous coal to assume the character of coke before it is thrust back upon the fire.

Dead Reckoning. A term used in Navigation to express the estimation that is made of a ship's place without having recourse to observation of the heavenly bodies. It is made by observing the way she makes by the log, and the course on which she has been steered, making allowance for drift, leeway, &c.

Dead Sea. The name given to a remarkable tract of country in Palestine, depressed very considerably below the sea level, but only covered with water in the deepest parts. The depression—meaning by that expression the area below the level of the sea—is a long narrow basin, the length being 200 miles, and the breadth less than 20 miles. About one-fourth is now covered by water. It includes the two lakes called the Dead Sea and the lake of Tiberias, which are 60 miles apart, and the river Jordan, by which they are connected. The depth of the ordinary surface of the water of the Dead Sea below the Mediterranean is 1,388 feet, and the depth of water in its deepest part is [illegible] feet, showing a total depression of 2,738 feet. The adjacent land, however, is a table-land [illegible] feet above the Mediterranean, so that the whole gorge is nearly 6,000 feet deep; the gorge is continued, though less abruptly, through the Red Sea into the Indian Ocean. A [illegible] watershed, 113 feet above the Red Sea, separates the waters of the Dead Sea from those that communicate southwards with the Indian Ocean.

The properties of the waters of the Dead Sea are remarkable and well known. They are 1. Great specific gravity—amounting to 1·25, or one-fourth greater than pure water, so that many substances float in it which sink at once in a pond or the sea; and, 2. Intense saltness, nearly seven times that of the sea, but varying extremely at different seasons, being sometimes only about 22 per cent. and at other times more than 44 per cent. of the whole. About 24½ per cent. may be considered the average proportion by weight. The chlorides of sodium, magnesium, and calcium are the most abundant salts, and there is also some chloride of potassium. Assuming that the whole depression was originally covered with sea-water, and evaporated down to its present state after communication with the sea had been cut off, the supply of fresh water being insufficient to meet the evaporation, there would be a deposit of common salt and carbonate of lime formed at the bottom during a large part of the year, and after rain other deposits with less salt would alternate. 'In this way,' says Bischof (*Elements of Chemistry and Physical Geology*), 'there must arise a constant alternation of different irregular layers of greater or less thickness. All these layers must contain gypsum, since in a water which holds so much chloride of magnesium as is present in the Dead Sea, gypsum is dissolved with difficulty, so that all the sulphate of lime originally in the sea-

water, as well as that carried in by the rivers, will be carried to the bottom.' There can be little doubt that this as well as many other known deposits of salt may have been formed in the way here indicated.

There is reason to suppose, from ancient sculptures in Egypt, that the level of the waters of the Dead Sea is not lower now than it was three thousand years ago. The balance has probably long been struck between evaporation and water-supply. On the whole, the evidence with regard to the Dead Sea and the country near it shows the existence of a remarkable fissure, not greatly unlike some of the fiords of Norway. This fissure extends first from the base of Mount Hermon to the Red Sea, a distance of 350 miles, where it meets the gulf of Suez, and thence nearly in a straight line for a further distance of about 1,200 miles to the straits of Bab-el-Mandeb.

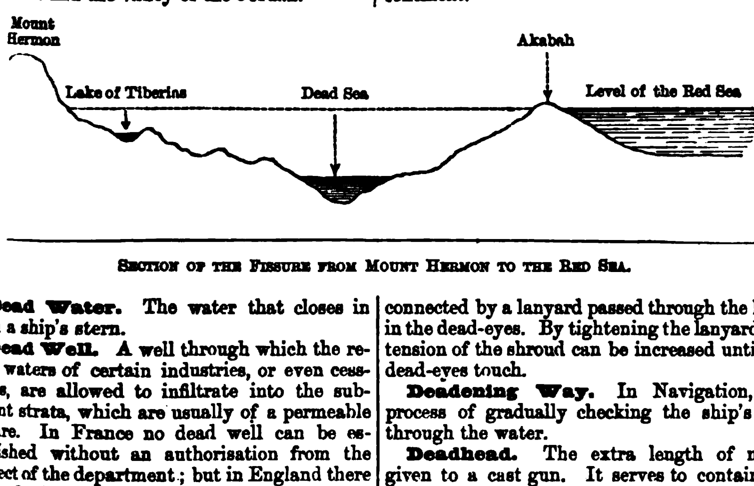
This great fissure separates Asia from Africa, and its breadth increases gradually, with the intervention of some necks, from a few yards in the north to as much as 200 miles at the opening of the Indian Ocean; while the depth, though not fully known, is in the Dead Sea, and probably throughout, but also with intervals of shallowing, more than 400 fathoms below the level of the Mediterranean.

By this contraction and shallowing, the fissure is divided into three basins, the main body of the Red Sea, the gulf of Akabah, and the depression of the Wady-Arabah, the latter including the Dead Sea and the valley of the Jordan.

The gulf of Akabah and the Red Sea are still connected by a narrow strait, which has an island in the middle and two banks or shoals projecting from it in opposite directions, leaving intermediate channels, the best of which is little more than half a mile wide, though of great depth.

It is only necessary to suppose that the depression to the north, now left dry, was formerly also covered with water, and separated from the gulf of Akabah by the gradual elevation of the land now forming the watershed on an axis transverse to that of the original fissure, to account for the separation of the former gulf from its southern continuation; and then the natural process of evaporation, continued for a sufficient period, could only result in the phenomena now presented. Should the channel between the gulf of Akabah and the Red Sea be closed, a similar result must happen.

It is interesting to observe that the gulf of Suez, the north-western fork of the Red Sea, was formerly continued in all probability to the Mediterranean, but is now cut off by the isthmus of Suez, in which there remains a small basin depressed below the Mediterranean, and also occupied by a salt lake like the Dead Sea. The lofty elevations of Dzebel Tor (Mount Sinai) and the volcanic nature of the rocks in parts of the wilderness between Egypt and Palestine are fully sufficient to justify the assumption of a comparatively recent elevation in this part of the great land of the old continent.



Section of the Fissure from Mount Hermon to the Red Sea.

Dead Water. The water that closes in with a ship's stern.

Dead Well. A well through which the refuse waters of certain industries, or even cesspools, are allowed to infiltrate into the subjacent strata, which are usually of a permeable nature. In France no dead well can be established without an authorisation from the prefect of the department; but in England there is no legislation upon the subject, and all the wells in a neighbourhood may thus be poisoned by the establishment of one of these dead wells.

Dead-eyes. On Shipboard, a species of blocks without sheaves. Each has usually three holes through it. They are employed in tightening the standing rigging; one dead-eye, for instance, being fastened to the chain and another to the foot of the shroud; these are then connected by a lanyard passed through the holes in the dead-eyes. By tightening the lanyard, the tension of the shroud can be increased until the dead-eyes touch.

Deadening Way. In Navigation, the process of gradually checking the ship's way through the water.

Deadhead. The extra length of metal given to a cast gun. It serves to contain the dross, which rises to the top of the liquid metal, and which, were it not for the *deadhead*, would be at the muzzle of the gun. When cooled and solid, the deadhead is cut off.

Deafness (Ger. taub, *deaf*). An imperfection of the sense of hearing, arising from a variety of causes, some of which are inexplicable and incurable, and others ascertainable and susceptible of relief or entire removal. When the organ of hearing is imperfect in its

functions, either at birth or in childhood, dumbness or imperfect articulation attends it; for speech is an imitative faculty, and an infant born deaf cannot attempt those motions of the organs of voice which gradually attain perfection by practice; he consequently becomes incapable of communicating his ideas through that medium.

The external ear, though tending by its form and situation to improve and perfect the sense of hearing, is in no way necessary; for it may be cut off without producing deafness. A common cause of deafness arises from imperfections or obstructions in the passage leading from the external ear down to the membrane of the tympanum. This passage is partly cartilaginous and partly bony; and from its oblique direction it is difficult so to see into it as to ascertain the seat or cause of the obstruction. In some persons, however, when placed in a proper position, so that the sunshine or other strong light may be properly directed into it, a little management enables us to examine nearly its whole extent. In some cases of congenital deafness this passage is closed by a membrane, which, if near the external orifice, is easily detected, and may be divided or removed; but, if deeply seated, it may escape observation till the child attains a certain age, or should begin to talk; for till that time the deafness of infants often passes unobserved. Under these circumstances, and where the malformation exists in both ears, and the child is dumb as well as deaf, a timely operation may effect the double benefit of giving both hearing and speech. Where the passage to the tympanum is more extensively obliterated or malformed, the cases become of course more complicated, but yet often admit of cure by a skilful and timely operation.

The presence of foreign bodies in the aural passage is a common cause of imperfect hearing, and sometimes it is obstructed by accumulations of hardened wax. These causes of deafness may in most cases be relieved or removed by syringing the ear with warm water, which should be forcibly injected, and so directed as to reach the membrana tympani. Insects or worms in the ear may be washed out in the same way, or killed by the introduction of a few drops of olive oil, or of camphorated oil.

Another cause of deafness is deficient secretion of wax, occasioning a dryness of the tube of the ear. It is relieved by greasy applications, and by the cautious use of stimulants, such as olive oil, to which a few drops of oil of turpentine, or of compound camphor liniment, or spirit of ammonia, have been added.

In cases of inflammation of the tympanum followed by suppuration, more or less deafness ensues, dependent upon the extent of the mischief going on, and requiring prompt, and generally antiphlogistic treatment: the pain, especially at the outset of the disorder, is often intense, and the discharge purulent and offensive. The deafness that attends a violent cold is frequently dependent upon obstructions in the Eustachian tube, and goes off when the secretions of the part return to their natural state.

Lastly, hardness of hearing often appears to depend upon imperfection in the functions of the auditory nerves, in which case constitutional rather than local treatment must be resorted to.

Deal. In Architecture, the small thickness of timber into which a piece of wood of any sort is cut up; but the term is at present improperly confined in its signification to the wood of the fir-tree cut up into thicknesses in the countries whence deals are imported, viz. Christiania, Dantzic, St. Petersburg, &c. Their usual thickness is three inches, and their width nine inches; they are purchased by the hundred, which contains 120 deals of twelve feet length, be their thickness what it may. The best deals are those obtained from Gefle, St. Petersburg, Christiania or Dramm in Norway.

Dean (Lat. decanus). An ecclesiastical dignitary in cathedral and collegiate churches, being the head of the chapter of canons or prebendaries, and forming together with them a council to advise the bishop in the affairs of his see. [Chapter.] In England there are, properly speaking, three classes of ecclesiastical presidencies to which the title *dean* belongs: deans rural, deans of cathedrals, and deans in peculiars. Rural deans were originally beneficed clergymen appointed by the bishop to exercise a certain jurisdiction in districts of his diocese remote from his personal superintendence. They seem to have been equivalent in many respects to the chorepiscopi of the early church, and many parts of their office are now discharged by the archdeacons. Rural deans are still occasionally employed in visitations, to examine into the state of repair of churches, and performance of divine service; their functions had for many years been almost obsolete, but in recent times have been generally revived in the English dioceses. Deans of cathedrals have already been noticed. The third species of deans, or deans in peculiars, are those of 'particular parishes and churches or rural districts that have jurisdiction within themselves, and are not under the ordinary of the diocese.' These are very few in number, as the deans of Bocking, Battle, &c. In Scotland, the head of the faculty of advocates is called the *dean*; and in the Scottish municipal system, the *Dean* of Guild is the second magistrate, having the care of all buildings public and private, and discharging functions somewhat equivalent to those of the Roman ædile.

Death (Ger. tod). Has been defined by Dr. J. Hughes Bennett as the permanent cessation of those properties and functions which constitute Life [which see]. It is either local or systemic. Local death is exemplified in mortification, ulceration, necrosis, or caries. Systemic death may be reducible to three several modes. 1st. Death by syncope, i.e. beginning at the

heart; 2nd. Death by **asphyxia, at the lungs**; and, 3rd. Death by **coma, at the brain.** It may be also produced by a combination of two or three of these modes: e.g. chloroform may kill, from the conjoined stupefying action on the brain, as well as the difficulty of respiration; coma, through pressure on the brain affecting the *medulla oblongata*, may influence the pneumogastric nerves, which send branches to the heart and lungs.

Death Watch. [ANOBIUM.]

Débacle (Fr.). A rush of waters, breaking down all opposing barriers, and carrying away and dispersing the broken fragments of rocks.

Debenture. In a general sense, any writing which acknowledges a debt; but it is more particularly applied to custom-house certificates entitling the exporter of goods to a drawback or bounty; and to the acknowledgments given by railway companies for special loans, as distinguished from ordinary shares. The term also signifies an instrument in use in some government departments, by which government is charged to pay to a creditor or his assigns the sum found due on auditing his accounts.

Déblai (Fr.). In Fortification, the quantity of earth excavated from the ditch to form the parapet. [REMBLAI.]

Débris (Fr.). In Geology, the fragments of rocks, &c.

Debt (Lat. debitum, from debeo, *I owe*). In Law, is a species of contract, whereby a *chose in action*, or right to a certain sum of money, is mutually acquired and lost: usually divided into debts of record, debts by special contract, and debts by simple contract. A debt of record is a sum which appears to be due by the evidence of a court of record; such as debt on judgment or recognisance. Debt by specialty is where a sum is acknowledged to be due, or becomes due, by instrument under seal; such as a covenant, bond, &c. Both these species of debts, being contracted by a man for himself and his heirs, attach on his lands and tenements, and bind them in the hands of his heir or devisee. Debt by simple contract is either by parole or by written obligation unsealed; within which class fall bills of exchange and promissory notes.

DEBT is also a personal action of contract, in which the plaintiff seeks the recovery of a debt; i.e. a *liquidated* or certain sum of money alleged to be due to him. [ACTION.]

Debt, National. [NATIONAL DEBT.]

Début (Fr.). In its most general acceptation, is applied to the commencement of any undertaking, or to the first step made in a public career; but it is confined more particularly to the language of the theatre, in which it signifies the first appearance of an actor, or his first appearance on any particular stage.

Decade (Gr. δεκάς). A word used by some old writers in a general sense for the number ten, or an enumeration by tens; but more peculiarly appropriated to the number of books into which the history of the Roman empire by Livy is divided, each division consisting of ten books or *decades*. It was also the name given to the space of ten days, which in the French republican calendar was substituted for the ordinary week. Thus, except in bissextile years, the whole number of decades was thirty-six and a half: the days of the half-decades, falling at the close of the year, were at one time called *sansculottides*, and afterwards *complementary*; and dedicated respectively to Virtue, Genius, Labour, Opinion, and Recompense.

Decagon (Gr. δέκα, *ten*, and γωνία, *an angle*). A geometrical figure, having ten sides and ten angles. If the sides and angles are all equal, the figure is a regular decagon, and inscribable in a circle. Euclid, in the fourth book of his *Elements*, shows that the side of a regular decagon is equal to the greater segment of the radius of the circumscribing circle divided by a medial section, or so that the rectangle contained by the whole radius and one of the parts is equal to the square of the other part; consequently, if we denote the radius by r, and the side of the decagon by s, we shall have the proportion $r : s :: s : r - s$; whence $s^2 + rs = r^2$, and by solving the quadratic $s = \frac{1}{2} \cdot r\,(\sqrt{5} - 1)$. If the radius is unit, $s = \frac{1}{2}\,(\sqrt{5} - 1) = \cdot 618034$; and the area $= 7\cdot 694209 \times s^2$, or $7\cdot 694209$ of the square on the side.

Decalitre (Fr.). A measure equivalent to ten litres. [LITRE.]

Decalogue (Gr. δεκάλογος). The name given to the ten commandments contained in Exod. xx. That their number was understood by the Jews to be ten appears from Exod. xxxiv. 28; but they differed from us in the manner of dividing them, considering our first and second as one, and separating the last into two. The same method is adopted by the Romish church, which professes to follow the authority of St. Augustine. (*Catechismus ad Parochos.*)

Decameron (Gr. δέκα, *ten*, and ἡμέρα, *day*). The name given by Boccaccio to his celebrated collection of tales: they are supposed to be narrated in turn, during ten days, by a party of guests assembled at a villa in the country to escape from the plague which raged at Florence in 1348.

Decandrous (Gr. δέκα, and ἀνήρ, *a male*). In Botany, a plant having ten stamens.

Decantation. The pouring off a clear liquid from its subsidence or residue; it is often resorted to in the chemical laboratory instead of filtration, the clear supernatant liquor being poured or siphoned off from precipitates, which may thus be repeatedly washed or edulcorated, so as to free them from all soluble matters.

Decapitation. A mode of punishment of great antiquity. Among the Continental nations of modern times it is the ordinary punishment inflicted on all capitally convicted criminals. In England it long ago became a punishment appropriated only to criminals of the highest rank. The last instance of the infliction of this punishment in England occurred in 1746, soon after the rebellion in Scotland had been quelled.

Decapod, Decapoda (Gr. δέκα, and πούς, *a foot*; *ten-footed*). A name applied by Dr.

Leach to a tribe of Cephalopods, including those which have ten locomotive and prehensile appendages proceeding from the head; two of which are always longer than the rest, and are called *tentacles*. Also applied by Cuvier to designate an order of Crustaceans, comprehending those which have ten thoracic feet.

Decapterygians, Decapterygia (Gr. δέκα, *ten*, and πτέρυξ, *pinion*). A name given by Schneider to an artificial division of fishes, including those which have ten fins.

Decarbonisation of Cast Iron. This process is resorted to in order to convert cast iron into steel, or by a further decarbonisation to reduce it to the state of malleable iron. Hence, many articles which were formerly exclusively manufactured of wrought iron are now cast, and afterwards decarbonised, such as horse-shoes, &c.; and in other cases various cutting instruments are cast, and afterwards brought to a proper condition by a similar process. The articles to be decarbonised are packed in finely powdered hæmatite, or native oxide of iron, and exposed for a sufficient time to a high red heat. It is often necessary to mix iron filings or turnings with the hæmatite: these substances, thus applied, gradually abstract the excess of carbon in cast iron, and reduce it to a state analogous to that of steel; or, by a longer continuance of heat, to that of soft iron. Decarbonisation may also be effected by blowing a current of air through cast iron in a state of fusion, by which, if carefully performed, a part, or the whole, of the carbon may be burnt and driven out in the form of carbonic acid.

Decastyle (Gr. δεκάστυλος). In Architecture, a building having ten columns on the front or on the flank.

Decasyllabic. Having ten syllables. In the German and English languages the ordinary heroic verse is decasyllabic; but a short syllable is sometimes added at the end by way of variety, and this, in consequence of the structure of those languages, takes place more frequently in the former than the latter. In the Italian heroic verse the eleventh syllable is almost uniformly added, and hence it is more properly to be termed an *hendecasyllabic*. In French versification the decasyllabic line is appropriated to light compositions, especially tales.

Decay. The gradual destruction of building materials is known in works upon Architecture by this name. It differs from decomposition, inasmuch as decay may take place without any change in the nature of the constituent elements of the stone; whereas decomposition always implies that a change of some kind has taken place. (*Dictionary of Technical Terms* by the Architectural Publication Society, art. 'Decay.')

Decay. [Eremacausis.]

December (Lat. decem, *ten*). The tenth month in the calendar of the ancient Romans, who began the year with March.

Decemviri (Lat.). Properly any body of ten men appointed for particular purposes. But that which is especially known by this name was the commission elected from the Roman patricians in what is called the 302nd year after the foundation of the city, and invested with all the supreme powers of the state, for the purpose of drawing up a body of laws founded, according to Roman tradition, on the more approved institutions of Greece. They presented to the people a number of laws engraved on ten tables, containing a summary of the privileges to be enjoyed by the people, and the crimes to be punished, &c. At the same time they informed the people that their plan was incomplete; and accordingly a new commission, to which the plebeians were admitted, was appointed for the next year, with the same powers; the result of which was the addition of two more tables to the former ten, thus making up the famous twelve tables, which were the foundation of all Roman law in subsequent times. The second decemvirate, we are told, did not demean itself with the same moderation as the first, but sought to prolong its power, and at the same time proceeded to some violent acts of despotism, which so exasperated the people as to make its dissolution necessary. But the whole history of the decemvirate is full of inconsistencies and difficulties which have been forcibly exhibited by Sir G. Cornewall Lewis, in his work on the *Credibility of Early Roman History*.

Besides these extraordinary commissions, there was a body of decemviri chosen for judicial purposes, to preside over and summon the centumviri, and to judge certain causes by themselves. There were likewise decemviri appointed from time to time to divide lands among the military.

Deceptive Cadence. In Music, a cadence in which the final close is avoided by varying the final chord.

Decidua (Lat.). In Anatomy, a product or an alteration of the mucous membrane of the uterus, preparatory to the reception of the impregnated ovum, which is discharged at parturition. When the ovum enters the uterus, it becomes embedded in the decidua, which yields and is protruded inwards, and becoming more and more inverted as the ovum grows, it is called the *decidua reflexa*, while the other part of the membrane is called the *decidua vera*.

Deciduous (Lat. deciduus). In Botany, is applied to plants whose leaves fall off in the autumn, in contradistinction to evergreens.

Deciduous. In Zoology, a term applied to parts which have but a temporary existence, and are shed during the lifetime of the animal, as certain kinds of hair, horns, and teeth.

Decimal Arithmetic. The common system of arithmetic, in which the scale of numbers proceeds by tens. [Arithmetic.]

Decimal, Circulating or Recurring. [Circulating or Recurring Decimal.]

Decimal Fraction. A fraction whose denominator is a *decimal number* or power of

ten. Thus $\frac{1234}{100}$ is a decimal fraction. It may be decomposed into the sum

$$\frac{1000}{100} + \frac{200}{100} + \frac{30}{100} + \frac{4}{100}$$
$$= 10 + 2 + \frac{3}{10} + \frac{4}{100}.$$

By an obvious extension of the method of local values, where each digit has ten times the value of the like digit which immediately succeeds it, the above decimal fraction may clearly be written more concisely in the form 12·34, where the *decimal point* after the 2 merely serves to indicate which digit represents *units*. In this abbreviated form a decimal fraction is termed a *decimal*. For the purpose of indicating the unit's place, other and less objectionable methods have been proposed. Sir Isaac Newton's method, however, of using a point, placed for distinction near the top of the figures, is the one most commonly employed. The operations of addition, subtraction, multiplication, and division may be applied to decimals in exactly the same manner as to integers; hence their great utility. The only additional rules in decimals refer to the position of the decimal point, and these are easily retained.

Decimal fractions appear to have been introduced by Regiomontanus, about the year 1464; but Stevinus was the first who wrote an express treatise on the subject, in his *Practique d'Arithmétique*, published in 1582. In their abbreviated form, as decimals, they are now universally employed in all arithmetical calculations; and it is much to be regretted that a decimal division of weights, measures, money, &c., has not been adopted in all civilised countries, by which the reduction of fractional parts from one scale to another would be obviated, and all the applications of arithmetic to the ordinary purposes of life greatly simplified. A subdivision of weights and measures on this principle was adopted in France at the time of the Revolution, but has only been partially imitated by other countries.

Decimal or Metrical System. The plurality of weights and measures in the various parts of France, due to the fact that the kingdom had been at different periods divided into several independent, or nearly independent, governments, was found to be a serious hindrance to internal trade. This evil had long occupied the attention of the French savans, and a remedy was at length proposed by the Constituent Assembly. It was conceived that the universal adoption of a system of weights and measures which should be based on some natural and invariable element would be a great international benefit, and the National Assembly petitioned the king by a decree of May 8, 1790, to the effect that communications should be made to the king of Great Britain, in order to procure the concurrence of the English parliament, for the establishment of a joint commission of the Academy of Science and the London Royal Society, whose business should be the carrying out an international system of weights and measures. The decree contains a suggestion that the basis of the system should be taken from the length of a pendulum at the latitude of 45° north. The scheme did not, it seems, attract much attention in this country; and Macpherson, whose collection of facts bearing upon trade and commerce at this period is very minute, makes no mention of the proposal.

A commission, however, was formed in France, of which Laplace was a member. It continued its workings during the time of the revolutionary government, and some persons served on it even from other countries. After the break-up of the Republic, the scheme, like every act of the revolutionary era, became unpopular, though during the consulate Napoleon gave in his adhesion to the plan, and furthered it. After a time, however, he became one of its strongest opponents. The metrical system was equally unpopular under the régime of the Restoration, the elder Bourbons identifying it with the dogmas of the Revolution. Still it had been for some time used by many scientific and professional bodies, and by some official departments, as, for instance, the French Board of Works and the Admiralty.

The community at large, however, exercised their discretion in the employment of the new or the old weights and measures, till, in July 1837, the government of Louis Philippe passed a law by which the adoption of the system was made compulsory, though the regulation was not to take effect till January 1840. No difficulty was found in carrying out the provisions of this law. The French people have accommodated themselves to the change, and, according to the testimony of M. Chevalier (*Parliamentary Report* 411, 1862, p. 60), the metrical system has given universal satisfaction, and has simplified commercial transactions to the fullest extent that could have been anticipated. The machinery by which the system was enforced was very easy. The Vérificateur des Poids et Mesures visits the shops in his arrondissement, and inspects the weights for the benefit of the customers. This official is instructed to inhibit all but metrical measures; and as the transfer of land is registered in France, and must be transacted before a notaire, this person is forbidden to use any other than the divisions of the are.

The basis of the decimal system in France is the mètre. This measure of length is equal to the estimated ten-millionth part of the distance between the north pole and the equator, the calculation having been taken from the measurement of an arc of the meridian, comprised between Dunkirk and Barcelona, and the result being reduced precisely. The mètre is rather more than the English yard, 100 mètres being equal to 119·6046 yards.

The superficial measure is the are, which is equal to the square of ten mètres; the solid measure is the stère, that is, the cube of a

mètre; the liquid or dry measure, the litre, i.e. the cube of the tenth part of a mètre; while the unit of weight is the gramme, i.e. the cube of the hundredth part of a mètre of pure water at the temperature of 32° Fahrenheit, or 0 centigrade.

The multiples and divisors of these quantities are decimal, the former being taken from the Greek, the latter from the Latin. Thus deca, hecto, kilo, myriagramme represent respectively 10, 100, 1,000, 10,000 grammes; while deci, centi, milligramme, are respectively, ·1 ·01, ·001 parts of a gramme.

The following are the several weights and measures reduced to English values:—

Gramme	.	15·4327 grains.
Mètre	.	39·3709 inches.
Litre	.	1·7608 pints.
Are	.	119·6046 square yards.
Stère	.	1·308042 cubic yards.

The decimal system is beyond question an economy of time in calculation. Beginning with a unit of *low* quantity, its adaptation to the easy determination of weights, both of great and small amount, has caused it to be adopted in quantitative analysis, and in some commercial transactions. Besides, as it is derived from a natural fact, it could be adopted by all nations without wounding national vanity; and it is superfluous to argue that a uniform international system of weights and measures would be of the greatest possible benefit, both as an economy and as enlarging and solidifying commercial relations between communities. Nor are the practical difficulties of real importance, for the experience of the system in France is conclusive as to the readiness with which the advantages of the decimal method are recognised and accepted.

But there are considerable difficulties in the adaptation of the decimal system to an international currency. Of the advantages which such a currency would confer, there can indeed be but one opinion; and ultimately the interests of nations and the progress of commercial diplomacy may perhaps induce the change; but it will be necessary first that the measure of value should be taken in the same metal. At present the standard in England and some Continental states is gold; in France and the majority of European communities it is silver. Next, the unit must be small or of low value. If it be large, as the subdivisions under the decimal system become fractional after the first division, the system would be more cumbrous and inconvenient than the custom which it is intended to obviate—a custom which is partly decimal, partly duodecimal.

It has been suggested that the sovereign should be divided into a thousand mils, the florin representing 100, and so on. This appears to be the best means for carrying out the decimal system in the United Kingdom, but it does not meet the larger and ultimately more important question of an international currency.

For the fullest information on this question, see the 'Report on Weights and Measures,' *Parliamentary Papers* 411, session 1861–2.

The decimal system is adopted in France, Belgium, Holland, Italy, Spain, Portugal, Switzerland, Greece, many countries in South America, and is slowly finding its way into Sweden and Russia.

Decimation (Lat. decimatio). In Roman History, the selection by lot of one man out of every ten, who was put to death as an example to, or satisfaction for, the rest, in cases of mutiny or failure in military duty. This practice has been occasionally recurred to in modern times; as by the Spanish general Cuesta, after the battle of Talavera.

Deck (Ger. decke, *a covering*, and dach, *a roof*). On Shipboard, a platform of planks laid upon the beams and carlings, forming a flooring for those above and shelter for those below. In addition, it is the support of guns, cargo, &c., and, when the hatches are battened down, the means of keeping the waves out in tempestuous weather. To make them water-tight, the planks are caulked and pitched between. In large vessels there are several decks, as the *upper*, *main*, *lower*, and *orlop* decks.

Declamation (Lat. declamatio). Signified among the ancients, the art of speaking indifferently upon both sides of a question. In modern times the meaning of *declamation* is different in different countries. In Germany and in most parts of the Continent, it is often used in a sense nearly synonymous with *recitative*. In France and England, especially in the latter, it is sometimes applied to any set oratorical display, either in the pulpit, at the bar, in the senate, or on the stage. But it is employed most usually in a disparaging sense, to indicate the use of forced emphasis and inflated language to withdraw the attention of the hearer from the weakness or fallacy of the reasoning. [Eloquence.]

Declaration (Lat. declaratio). In Law, a legal specification, on record, of the cause of action, by a plaintiff against a defendant. [Pleading.]

Declaration, Dying. In English Law, an exception to the rule that hearsay evidence is not admissible [Evidence], is admitted in the case of homicide; where the declaration made by a person in immediate expectation of death as to the circumstances of his mortal injury is received, although he cannot be present to give evidence in court.

Declension (Lat. declinatio, from declino, *I deflect*). In Grammar, the changes of termination in nouns, corresponding to the various relations in which substances are conceived to stand. [Case and Grammar.]

Declination of a Celestial Body. The angular distance of the body north or south from the celestial equator. It is measured on the great circle which passes through the centre of the body and the two poles of the heavens, and is consequently perpendicular to the equator; or it may be defined to be the arc of a circle of declination, passing through the place of the

heavenly body, intercepted between that place and the celestial equator. The place of a star in the heavens is determined by means of its *right ascension* and *declination*; the *right ascension* being the angular distance, measured on the equator, between the first point of Aries and the point in which the circle of declination of the star intersects the equator, measuring from the first point of Aries eastward, or in the direction of the earth's motion round the sun. Right ascension and declination thus correspond to longitude and latitude on the surface of the earth. In the analytical theory of the planets it is often necessary to define the place of a planet or comet with reference to the ecliptic, or plane of the earth's annual motion; and the early astronomers unfortunately adopted for this purpose the terms *longitude* and *latitude*, which, as the same terms are appropriated to terrestrial objects in a different sense, is the cause of considerable embarrassment to beginners. The student of astronomy must therefore remember that in speaking of celestial objects, *declination* and *right ascension* have reference to the *equinoctial*, or plane of the earth's diurnal rotation; while *latitude* and *longitude* are measured respectively from and along the *ecliptic*.

The declination of a star is said to be *north* when the star is north of the equator, and *south* when the star is south of the equator.

Declination Circles. Great circles passing through the poles of the heavens. Parallels of declination are small circles parallel to the celestial equator.

Declination of the Magnetic Needle. The axis of a magnetic needle, that is, the straight line which joins its poles, does not coincide with the astronomical meridian, but deviates from it more or less, sometimes towards the west and sometimes towards the east. This deviation is called the *Declination of the Needle*.

The following table of observations, made at Paris, will be sufficient to give an idea of the changes which the declination of the needle has undergone at different epochs:—

Years	Declination	Years	Declination
1580	11° 30′ East.	1814	22° 34′ West.
1618	8 0	1817	22 19
1663	0 0	1819	22 29
1678	1 30 West.	1822	22 11
1700	8 10	1824	22 23
1767	19 16	1825	22 22
1780	19 55	1832	22 3
1785	22 0	1843	21 25
1805	22 5	1852	20 20
1813	22 28		

From this table it appears that since 1580 the declination has varied more than thirty degrees. In 1663 it vanished. From the date of the first observations till 1820, it has advanced progressively westward; but since that time it has assumed a retrograde movement towards the east. (Pouillet, *Élémens de Physique*, t. i. p. 462.)

The declination of the magnetic needle at London in 1865 was 20° 30′. [MAGNETISM.]

Declinometer. An apparatus for measuring the declination of the magnetic needle, or the force of terrestrial magnetism in the plane of the horizon. [MAGNETOMETER.]

Decoits or **Dacoos.** In Hindustan, the name given to associations of robbers who go about the country in gangs. The occupation is generally hereditary, as with the Thugs, with whom, however, they must not be confounded. [THUGS.]

Decollation (Lat. de, and collum, *the neck*). A word synonymous with *beheading*; used chiefly in reference to the decapitation of John the Baptist. This word is used by Fabyan so far back as the year 1350.

Decomposition, Chemical. When compounds are resolved into their elements, or when the chemical constitution of substances is altered, they are said to be decomposed; and when, in this operation, new products are formed, such products are called the *results of decomposition*. Thus, *ammonia* is the result of the decomposition of certain animal substances; *carburetted hydrogen gas* is the result of the decomposition of pit-coal, &c.

Chemists use the terms *simple* and *compound*, or *single* and *double* decomposition, to distinguish between the less and more complicated cases. When a compound of two substances is decomposed by the intervention of a third, which is itself simple, or which acts as such, the case is one of simple decomposition: water, for instance, is a compound of oxygen and hydrogen. When the metal potassium, which is a simple body, is thrown into it, it is decomposed; the hydrogen is liberated in the form of gas, and the oxygen combines with the potassium to form potassa. Such a case is often tabularly represented as follows; and the annexed numbers are the *equivalents* of the acting bodies, or the respective weights which are required for perfect decomposition:—

$$\text{Water 9.}\begin{cases}\text{Hydrogen 1.}\\ \underbrace{\text{Oxygen 8} + \text{potassium 39.}}_{\text{Potassa 47.}}\end{cases}$$

This shows that when 9 parts by weight of water are decomposed by 39 parts of potassium, 47 parts of potassa (or oxide of potassium) are formed, and 1 part of hydrogen liberated.

When two new compounds are produced, the result is called *double* or *complex* decomposition. Thus, when potassa (composed of potassium and oxygen) and hydrochloric acid (composed of hydrogen and chlorine) react upon each other, chloride of potassium (composed of chlorine and potassium) and water (composed of hydrogen and oxygen) are the results. These, with their respective *equivalents*, are shown in the following diagram:—

Water 9.

$$\text{Hydrochloric acid } 37.\left\{\begin{array}{l}\text{Hydrogen } 1+\text{oxygen } 8.\\ \text{Chlorine } 36+\text{potassium } 39.\end{array}\right\}\text{Potassa } 47.$$

Chloride of potassium 75.

This table, therefore, shows that 37 parts by weight of hydrochloric acid and 47 of potassa produce, by mutual decomposition, 75 parts of chloride of potassium and 9 of water.

A knowledge of the mutual decomposing powers of different substances, or, in other words, of their relative affinities, constitutes the skill of the practical chemist. [AFFINITY; EQUIVALENTS; CHEMISTRY.]

Decomposition of Forces. In Mechanics, is synonymous with *resolution of forces*. [FORCES AND ROTATIONS.]

Decomposition of Light. The separation of a beam of light into the different rays which constitute the prismatic colours. [LIGHT.]

Decoration (Lat. decorare, *to adorn*). In the Fine Arts, the decoration of any work should be confined strictly to the developement of impressions which the mass itself is intended to create in strict accordance with its use; its object being merely to present new images which spring from the original bare design. All decoration or ornament must be accessory, never principal, or overloading its object. The ornaments chosen should be in absolute æsthetic accordance with the object adorned; for example, a vessel which is designed to hold liquid should never be so ornamented as to represent basket-work, which is æsthetically antagonistic in its suggestion to the use of the object decorated. [ORNAMENT.]

Decoy. A device by which aquatic birds, chiefly ducks, are enticed from a river or lake, up a narrow winding canal or ditch, which, gradually becoming narrower, at last terminates under a cover of network of several yards in length. The birds are enticed by the smoothness of the turf on the margin of the canal, which tempts them to leave the water, and begin to dress their plumage. When so engaged at some distance up the canal, they are suddenly surprised by the decoy man and his dogs, who have been concealed behind a fence of reeds; and having again taken the water, they are driven up by the dogs till they enter within the network which terminates the decoy, and are then readily caught.

Decree, Decretals (Lat. decretum). Decreta or decrees in the Civil Law, are the decisions of emperors on cases submitted to them, forming a part of their constitutions. Decretals were the decrees of popes, having the same authority in canon law as decrees in civil. They retained this authority in most Catholic countries until the fourteenth century. The first authentic decretal was issued by Pope Siricius, A. D. 385: it prohibited the marriage of priests and deacons. But during the pontificate of Nicolas I. there suddenly appeared fifty-nine letters and decrees of the twenty oldest popes from Clement to Melchiades. This spurious collection, which contained the Donation of Constantine, with thirty-nine false decrees, and the acts of several unauthentic councils, introduced among the decrees of popes and councils from Silvester to Gregory II., asserted the absolute supremacy of the popes, and maintained the whole Romish system of dogma and discipline. The authorship of this fraud is not known; but the date of their appearance can be determined within a few years. They were certainly completed after A. D. 829, and were not less certainly published before A.D. 847. (Milman, *History of Latin Christianity*.)

DECREE. In Law, the judgment of a court of equity on any bill preferred. Either party may petition the court for a re-hearing before it is signed and enrolled. After that form has been gone through, a bill of review may be had upon apparent error in judgment on the face of the decree. It may also be appealed against in the House of Lords. In Scottish law, various legal judgments and sentences are styled *decreets*.

Decrement (Lat. decrementum). The part by which a variable quantity is conceived to be diminished. It is opposed to *increment*, a term of frequent use in the differential calculus.

Decrepitation (Lat. crepito, *I crackle*). The crackling noise which common salt and many other substances make when thrown into the fire. It is generally occasioned by the conversion into vapour of small portions of water imprisoned in the interstices of the substance, the latter being torn to pieces by the expansive force of the vapour so generated.

Decurio. The Latin name for the commander of ten men. A military decurion was a cavalry officer, who originally commanded ten soldiers, or one-third of a turma; but afterwards the same name was preserved, though the command was extended to the whole turma. Municipal decurions were magistrates in the municipal towns, answering to senators at Rome. In later times also certain officers of the imperial household used this title: as decurions of the chamberlains, &c.

Decussate (Lat. decussatus, *crossed*). Applied to the arrangement of bodies in pairs that alternately cross each other; as the leaves of many plants.

Dedication (Lat. dedicatio). In Literature, a complimentary address to a particular person, prefixed by an author to his work. The custom of dedicating works was in use at a very early period. Horace, Virgil, Cicero, and Lucretius were among the number of those who practised it. At the period of the revival of letters in Europe, few works were published without dedications. Many of these dedications are remarkable for their elegance and purity of style, and from the matter which they contain are of more value than the treatises to which they are prefixed. But the practice became gradually perverted; and many of the authors of the succeeding generations

employed them chiefly with the view of securing the patronage of the great. Dedications were most abused in France under Louis XIV., and in England from 1670 to the accession of George III. Dryden was a great dedicator, and Johnson wrote dedications for money. Corneille got 1,000 louis d'ors for the dedication of *Cinna*. Some of the most beautiful dedications with which we are acquainted are those prefixed to the different volumes of the *Spectator*, by Addison; and in more recent times the poetical dedications with which each canto of Sir Walter Scott's *Marmion* is prefaced. A complete history of dedications would be of great value, as throwing light upon the history and character of many distinguished persons which are now involved in obscurity. A few such works are in existence; but they are only accessible to the learned. (*De Dedica. Lib. vet. Lat.* by Walch, Leipzig 1715; *Commenta. de Dedica. Lib.* by Tacke, Wolfenbüttel 1733.)

Dedimus Potestatem (Lat.). In Law, a writ or commission given to one or more private persons, for the speeding an act appertaining to a judge or some court. When the commission of the peace is renewed, a writ of dedimus potestatem is issued out of chancery, directed to some ancient justice, to swear-in a justice newly inserted.

Deed (A.-Sax. dæd, Ger. that, *a thing done*). A deed, in Law, is a writing sealed and delivered by the parties. If made by one party only it is termed a *deed poll*; if by several, an *indenture*. The formal parts of a deed of conveyance are, first, the date and names of the parties; secondly, the recitals, in which the intention of the parties and former transactions with reference to the same property are recounted, so far as necessary; then the operative part. This expresses, first, the consideration for which the deed is made (which for many sorts of deeds is now merely nominal); then the conveyance by and to the several parties; then the parcels, or description of the tenements and their legal adjuncts; then what is termed the *habendum*, beginning with the words 'to have and to hold,' expressing the quantity of estate conveyed; then the declaration of uses, which limits or modifies the enjoyment to one or more parties, according to the stipulations previously made; then the declarations of trusts, if any, that is, of equitable interests created in the property; and lastly, the covenants for title. These covenants stand in the place of the ancient warranty, a clause by which the grantor warranted and secured to the grantee the thing granted; arising out of the feudal custom, whereby if a lord had thus warranted a fief, and the tenant was afterwards evicted, the lord was bound to recompense him with another fief of equal value. The covenants relating to the title secure to the grantee a pecuniary compensation for any damage he may suffer contrary to their stipulations. Besides the covenants for title, such as may be demanded by the peculiar circumstances of the case—as in a lease the covenants for repairing, payment of rent, &c.—covenants in general, when broken, give the covenantee an action for damages against the covenantor; or if he be dead, against his executor or administrators to the extent of his personal property in their hands; or if the covenant be with him, his heirs and assigns, the remedy extends to the heir or grantee of the covenantee.

Lastly, the conclusion of a deed contains its execution and date. It must be signed and sealed by the grantor; and also by the grantee, if any engagement or covenant is entered into by him. It is usual for witnesses to attest the deed; but this is not necessary, unless where, a power having been given to be executed by deed, the terms of the power require such attestation. There are several species of deeds; some having effect at common law, others under the Statute of Uses; some creating an estate termed *original* or *primary*; some enlarging, restraining, transferring, or extinguishing estates already created, which are called *secondary* or *derivative*.

Deemster, Dempster or **Demster** (A.-Sax. dom, *judgment* or *doom*). The title of judges in Jersey and in the Isle of Man. In Scotland, the word long since came to designate an officer who had to recite the sentence which had been pronounced by the court: this office is now abolished.

Deer (Gr. θήρ, Ger. thier, *a beast*). The English generic name for the ruminating quadrupeds with deciduous horns, or antlers; which appendages form, in fact, the essential character of the genus *Cervus* of Linnæus. [CORNUA.] Deer are anatomically distinguished from other ruminants by the absence of a gall-bladder.

The species of deer may be primarily divided into two groups, of which one includes those with antlers more or less flattened, the other those with rounded antlers. The elk (*Cervus Alces*, Linn.) is the most characteristic species of the first group, and forms the type of the subgenus *Alces* of modern systems. It equals or exceeds the horse in bulk; has a short body, with a still shorter neck, raised on long stilt-like legs. The muzzle is long, broad, and overhangs the mouth like a square-shaped lapel: it is very muscular, and is of essential service to the animal in detaching the lichens and mosses from the trunks of trees and other places within its easy reach. The long legs of the elk particularly adapt it to the marshy and swampy forests which it chiefly frequents, in the northern parts of both the European and American continents. The antlers of the elk appear first in the form of *dags* or unbranched pointed stems; these are succeeded by a stem or *beam* supporting a few short branches. At five years he puts up antlers in the form of a triangular plate, supported on a pedicle, and notched along the outer margin. Afterwards the bony plate increases in its expanse, and the points between the notches are developed into long branches or *snags*, of which a single antler sometimes sends off as many as fourteen;

and the pair will then weigh about fifty pounds. The female elk goes with young for rather more than eight months.

The rein-deer (*Cervus Tarandus*) differs from the rest of the genus in the presence of antlers in both sexes, and in the great developement of the *brow-antlers*, or branches which extend forwards over the forehead from the base of the beam. The antlers are retained through the winter; and, as it is understood that the brow-antlers are used to detach the frozen snow, which at that season covers the lichens on which the rein-deer feeds, the necessity of the singular exception in favour of the female rein-deer becomes obvious. Her antlers are, however, always smaller than those of the male. The rut takes place in mid-winter, and the period of gestation is about six months: as in most other species of deer, one fawn is produced at a birth. The rein-deer is a native of the most northern parts of Europe and America. To the Laplander it serves all the ordinary offices of the beast of draught, and supplies him with the nutriment, clothing, and useful implements, which man in more favoured climes obtains from other species of the valuable order of Ruminantia.

The third species of deer which may be referred to the flat-horned group is that which the ancients termed *platyceros*, and which now forms the ornament of the English park; the fallow deer (*Cervus Damas*, Linn.). In the technical language of the hunter, the male fallow deer is called a *buck*, the female a *doe*, and the young a *fawn*. The buck-fawn of the second year, which is characterised by having simple dags, is a *pricket*. In the third year a brow-antler is put forth, and the young buck is termed a *sorel*. In the fourth year he is a *sore*, and the summit of the beam presents a bifid expansion. At the fifth year the expanded summit of the beam is formed, and begins to develope snags, and the fallow deer is then a *buck of the first head*. At each subsequent year the branches of the expanded beam increase in length to a certain period, after which they lose their size and regularity. The period of gestation in the fallow doe is eight months.

Of the species of deer of which the beam of the antler gives a rounded form in section, the red deer (*Cervus Elaphus*) and the roe-buck (*Cervus Capreolus*) are indigenous species.

The male red deer, in the language of 'the noble art of venerie,' is called a *hart*, and the female a *hind*. She goes with young about a week longer than the fallow doe; and brings forth in May a single fawn, rarely two. The young of both sexes are at first styled *calves*. The male differs from that of the fallow deer in putting up at six months a pair of rudimental antlers, in the form of cylindrical knobs, called *bossets*. In the second year they assume the condition of *dags*, and the wearer is called a *brocket*. In the third year two or three branches or *tynes* are developed, and the young deer becomes a *spayad*. In the fourth year the summit of the beam expands into the crown or *surroyal*, and the deer is now distinguished by the name of *staggard*. In the fifth year the term *stag* is applied to him in a limited and technical sense. At the sixth year he is a *hart*, and his designation is not afterwards changed; but at this period he is particularly distinguished as a *hart of ten*, and is not considered fair game till his seventh year, when the hart is said to be *palmed* or *crowned*, in reference to the full developement of his antlers. The antlers or *attire* are shed very soon after pairing: at this period, when the hart has 'lost his attire,' he retreats to the shadiest or most unfrequented part of his range. New antlers begin to grow very soon after the old ones are shed, and they are completed in the month of August. The skin or *velvet* which protected the vascular periosteum during their growth, now dries, and is rubbed off against trees or any resisting body; this act is technically called *burnishing*. The harts during this period form a peculiar and distinct association. The hinds form another group, and go also into retirement with their calves, to which they attend with a high degree of instinctive maternal solicitude. The *brockets* and the *brockets' sisters* constitute a third association.

The roebuck is the smallest species of European deer; the male is monogamous, and the female brings forth two fawns. In our island they are now confined to the Scottish mountains.

The largest species of round-antlered deer in America is the *Wapiti* (*Cervus Strongyloceros*); that of Asia is the great *Rusa* (*Cervus Hippelaphus*), which is noticed in the writings of Aristotle. In South America there is a singular group of small deer, called *prickets* or *brockets*, the antlers being developed beyond the simple condition of *dags*, such as characterise the brocket age of the red deer.

Defæcation (Lat. defæcatio, from fæx, *dregs*). The separation of the dregs and impurities of liquors.

Defamation. [LIBEL.]

Default (Fr. défaut). In Law, is in a general sense the omission of any act which a party ought to do in order to entitle himself to a legal remedy. Such is, for example, non-appearance in court on a day assigned. If a plaintiff in an action make default in appearance, he is non-suited; if a defendant, judgment by default passes against him. Suffering judgment by default is taken for an admission of the contract alleged by the plaintiff.

Defaulter. In Military language, a soldier undergoing punishment by sentence of his commanding officer. All crimes and offences of soldiers are entered in a book, called the *defaulter book*.

Defeasance. In Law: 1. A collateral deed, made at the same time with a deed of conveyance, containing conditions on the performance of which the estate created by the deed of conveyance may be defeated. 2. A defeasance on a bond, recognisance, or judgment recovered, is a condition which when performed defeats a

bond, &c. [Bond], contained in or indorsed on the instrument itself.

Defective Fifth. In Music, an interval containing a semitone less than the perfect fifth. It is also called *semidiapente*, and *flat*, *lesser*, *false*, or *diminished fifth*.

Defence of Fortresses. [Fortification.]

Defence, National. [National Defence.]

Defendant. In English Law, the party against whom claim is made in an action or suit. In proceedings at law, the rule is now held to be that, in personal actions *ex contractu*, the action is brought against the person who either expressly or implicitly made the contract; in personal actions *ex delicto*, against the person who either actually committed the injury, or aided and assisted in committing it, or counselled or ordered the party to commit it; or against all or any of them.

Defender of the Faith (Lat. Fidei Defensor). A title bestowed by Pope Leo X. on Henry VIII. of England on the publication of his book against Luther. When at the Reformation Henry suppressed all the monasteries and convents in England, the pope deprived him of this title; but in the thirty-fifth year of his reign, it was confirmed by parliament, and it has been since constantly assumed by the sovereigns of England.

Deferent (Lat. defero, *I carry away*). In the Ptolemaic system of the universe the planets move in circular orbits, the centres of which are carried round in the circumference of other circles. These secondary circles are called the *deferents*, as carrying the orbits; those in which the planets move being the epicycles. The system of epicycles and deferents was invented by Hipparchus for the purpose of explaining the eccentricities, perigees, and apogees of the planets. [Epicycle.]

Deficient Number. In Arithmetic, is one which exceeds the sum of its aliquot parts. Thus 8 is a deficient number, since the sum of its aliquot parts 1, 2, 4, only amounts to 7. A deficient number is opposed to an *abundant number* in this respect.

Defilading. In Fortification, is (1) so arranging the height of a work that the enemy cannot see into it, or (2) so directing its faces that the enemy cannot enfilade them, or take them in reverse.

Defile (Lat. filum, *a thread*). In Military language, a narrow way, through which troops can pass only in *file*, or a small number abreast, and to *defile* is to pass an obstacle by reducing the front of the troops.

Definite Integral. Denotes the sum of a series of infinitesimal elements, whose first and last terms are given. If $f(x)\,dx$ be the general type of such an element, the sum of all such, as x increases from a to b, would be the definite integral represented by $\int_a^b f(x)\,dx$, of which a and b are said to be the *limits*. A definite integral is a function of its limits, and of the *constants* contained in its *element-function* $f(x)$, but does not in any way involve the variable x. In fact, if $F(x)+C$, where C is an *arbitrary* constant, be the function, whose differential is $f(x)\,dx$, then in general

$$\int_a^b f(x)\,dx = F(b) - F(a),$$

or as it is often written $[F(x)]_a^b$. The function $F(x)$ is termed the *indefinite integral*, and is usually indicated by the symbol

$$\int f(x)\,dx, \text{ or } d^{-1}[f(x)\,dx],$$

the latter being the notation employed in the calculus of operations.

Definite Proportionals. In Chemistry. [Atomic Theory and Equivalents.]

Definition (Lat. definitio). Literally, laying down a boundary. In Logic, it signifies a description which separates a term from everything else. By the schoolmen definitions were divided into *nominal* and *real*; the former setting forth the meaning of a word, the latter explaining the nature of a thing. There is also a division into *accidental* and *essential* definitions, the former describing by attributes, not included in the connotation; the latter by specifying the *genus* and *differentia*. Such definitions, Mr. Mill remarks, are always liable to be overthrown by the discovery of new objects in nature.

Deflagration (Lat. deflagratio, *a burning*). A chemical term applied to sudden and rapid combustion: when a mixture of charcoal and nitre is thrown into a red-hot crucible, it burns with a kind of explosion, or *deflagrates*.

Deflection (Lat. deflexio, *a bending downwards*). The change of form produced in a beam when its upper surface becomes depressed below its original level line, whether caused by an extraneous weight, or merely by that of the unsupported portion of the beam itself. The laws which regulate the deflection of beams have been thus stated by Coulomb: 1. The deflection below the natural level is proportional to the weight; 2. The weight required to produce depression is proportional to the width of the bar, but in the ratio of the cube of the depth; 3. It is in the inverse ratio of the cube of the length.

Deflection of a Projectile at any point of its flight, is its perpendicular distance, measured horizontally at that point, from a vertical plane passing through the prolongation of the axis of the piece from which it is fired.

Deflection of the Rays of Light. When a luminous ray passes very near an opaque body, it is *deflected*, or bent from its rectilinear course, towards the surface of the body, and the deflection is greater as the distance of the ray from the body is less. To this phenomenon, first observed by Grimaldi, Newton gave the name of *diffraction*.

Deforcement. In Law, a general name for the injury occasioned by the holding of lands or tenements to which another has a right, of property or possession. [Intrusion.]

Defter-dar (literally, *book-keeper*). The title given by the Turks to the chancellor of

the exchequer and his two coadjutors or deputies in the finance department.

Deglutition (Lat. deglutio, *I swallow*). In Physiology, the act of swallowing food. This operation is performed by mechanism of the most extraordinary and complicated kind, in which the consentaneous actions of the various muscles of the tongue, the soft palate, the pharynx, the larynx, and the œsophagus or gullet, are concerned, partly by voluntary and partly by involuntary impulse.

There are, as it were, four openings at the back part of the mouth, three of which, during deglutition, must be perfectly but temporarily closed; whilst the fourth, namely, that through which the food is to pass towards the stomach, must be open and without impediment. The openings which are to be closed are those which communicate with the nose, with the ears, and with the lungs: but, as far as the latter is concerned, it follows of course that respiration can only be suspended for a very short time, and that therefore the moment the morsel is swallowed, or has passed over the larynx, the communication between it and the nose must again be free.

When food is properly masticated, a sufficient quantity is collected upon the tongue, which is then so pressed against the palate by a muscular action proceeding from the tip of the tongue backwards, as to propel it towards the pharynx, or upper end of the gullet; at this moment the soft palate, previously hanging like a pendulous veil at the back of the mouth, is drawn into a horizontal position, so as to form a continuation, as it were, of the bony part of the palate, and at the same time to close the nasal canals. As soon as the morsel or portion to be swallowed reaches the pharynx, the base of the tongue, the os hyoides, and the larynx are raised forward to meet it, and hurry it over the opening of the glottis towards the œsophagus. The instant the larynx is raised, the glottis is firmly closed; and as soon as the morsel has passed over it the larynx descends, the epiglottis is raised, and the glottis opens again to allow air to enter the lungs. Thus it is, therefore, that the food is limited to the direction of the œsophagus, and neither passes into the nasal canals, nor into the Eustachian tubes, nor into the larynx, all the concurrent actions in this period of the act of deglutition being simultaneously and involuntarily performed. By the contraction of the pharynx the morsel is delivered into the œsophagus, and propelled by the muscular structure of that tube towards the stomach. In the upper part of the œsophagus, the fibres relax immediately after the passing of the food, but the inferior portion remains contracted for some moments after the food has entered the stomach.

The due admixture of saliva with the food, and the lubrication of the various and complicated parts over and through which the food passes, by mucous secretion, tend materially to facilitate the progress of the alimentary pellet.

Degradation (Lat. de, *from*, and gradus, *a step*). In Law, the act by which any person is deprived of a dignity or degree of honour. In the case of ecclesiastics, it is generally accompanied by the ceremony of taking away, one by one, their sacerdotal robes or ornaments, as in the case of Archbishop Cranmer. With knights, their spurs were hewn off their heels, and their swords broken over their heads.

Degree (Fr. degré, Lat. gradus, *a step*). A distinction of rank in universities: in its proper use denoting a certain amount of proficiency in the faculty or science of which it is entitled; but, by modern usage, frequently conferred as an honorary distinction. The origin of degrees at the universities of Paris and Bologna, the two most ancient in Europe, appears to have been only the necessary distinction between those who taught and those who learnt. The former were styled (such was at least the case at Paris) *doctors* or teachers, and *masters*, as a token of respect, indiscriminately. At what time the distinction between these two degrees arose we cannot ascertain; but about the middle of the thirteenth century we find, at Paris, doctors and masters simply as graduates, and not necessarily connected with the business of teaching; those who were so, being called *regent masters*, or simply *regents*. [Regent.] The degree of bachelor, the lowest in the several faculties, is certainly of French origin; whence it has been argued that the whole system of academical titles is so likewise. Degrees still continue to bear the same names, and, with some variation, the same relative academical rank, in most European countries; but the mode of granting them, and their value at different universities as tokens of proficiency, vary greatly. Honorary degrees, in the English universities, are generally conferred in civil law.

Degree. In Algebra, the magnitude of the greatest sum that can be formed by adding together the exponents of the facients or variables which occur in any single term of an equation or expression. Thus

$$a^2x^2 + b^2y^2 + c^2z^2 + 2bcy + 2cax + 2abxy$$

is said to be of the second degree in the variables x and y, and it is also said to be of the second degree in the coefficients a, b, c. The terms *degree* and *order* are frequently used synonymously in algebra, but have distinct meanings when applied to *differential equations*.

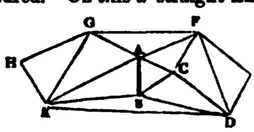
Degree. In Trigonometry, is the angle subtended at the centre of any circle by an arc equal to the 360^{th} part of its circumference, in other words it is the 90^{th} part of a right angle. A degree is subdivided into 60 minutes, and each minute into 60 seconds. The notation employed for an angle of six degrees fifty-two minutes and sixteen seconds is $6^\circ\ 52'\ 16''$. The above division of the circle is of very remote origin. It is not certainly known what gave occasion to the adoption of the arbitrary number 360; but it most probably had reference to the space described by the sun in one day in performing his annual revolution in the ecliptic, the number 360 being taken instead of 365, as being more

convenient for arithmetical operations on account of its containing a great number of divisors. The Chinese divide the circle into 365¼ equal parts; so that the sun describes daily an arc of one Chinese degree. An attempt was made by the French philosophers, at the period of the Revolution, to introduce into works of science a division of the circle better adapted to our decimal arithmetic (the quadrant or right angle being divided into 100 degrees, the degrees into 100 minutes, and so on); but though the system was adopted by some writers of the first order of merit (for example, Laplace in the *Mécanique Céleste*), and extensive tables were computed for the purposes of astronomical calculation, it never came into general use, and now appears to be entirely abandoned. It may be remarked, that a division of this sort was recommended long ago by some of the most eminent mathematicians, Stevinus, Wallis, Briggs, Gellibrand, Newton, and others.

DEGREE. In Grammar. [COMPARISON.]

Degree of Latitude. On the surface of the earth, is the distance an observer must advance along the meridian, to the north, or south, in order to produce a variation of one degree in the altitude of the pole. Ever since it was discovered that the earth is round, the exact measurement of a degree of the terrestrial meridian has been a problem of extraordinary interest, inasmuch as it leads directly to a knowledge of the earth's dimensions. In modern times the problem has acquired a still greater importance, in consequence of the discovery of the earth's ellipticity; for it is by the comparison of the lengths of meridional degrees at different latitudes that we are enabled to ascertain accurately the true figure of the earth, which enters as an element into many of the most interesting enquiries of physical astronomy and terrestrial physics.

When we consider the great irregularities of the actual surface of the earth, and that the length of a degree depends on the radius of the circle on which it is measured, it will readily appear that terrestrial degrees at different places, if measured on the external surface, must be exceedingly unequal. In order to obviate the effects of superficial irregularities, and to reduce all the degrees to the same radius, the surface of the sea is supposed to be continued all round under the continents, and it is to this surface or level that all the measurements must be referred. This being understood, the general principle on which the measurement of degrees of the terrestrial meridian must be accomplished are readily perceived. Two stations being assumed on the same, or nearly the same, meridian, the distance between them must be found with great exactness in feet, yards, or some known linear measure. Having ascertained the itinerary distance, the latitude of each of the stations must be determined; the difference of the two latitudes is the length of the celestial arc intercepted between the two stations; and by comparing this with the terrestrial measure, the number of yards or feet corresponding to a degree becomes known. It is evident that, in order to obtain a result of any value, all these operations must be executed with the greatest care and precision. An error of a single second in the celestial arc corresponds to about 100 feet on the ground, and a long series of astronomical observations must be made to obtain the latitude of any place true to a second. On this account it is necessary to measure an arc of considerable length, two or three degrees at least; because the error in the determination of the latitudes is the same, whether the arc be long or short, and in the case of a long arc its influence becomes less sensible. But the exact measurement of a line extending two or three degrees on the surface of the earth, by the direct application of rods or chains, is perhaps altogether impracticable, on account of the irregularities of the ground and many other circumstances which render an operation of this sort, when carried on even for a few miles, an affair of great difficulty. Hence it becomes necessary to have recourse to other methods. A level piece of ground is selected near the meridional arc proposed to be measured. On this a straight line A B is traced, in any direction, and its length accurately found by the application of rods of



metal, or sometimes of wood or of glass. The ground adjoining the arc to be measured is then formed into triangles by means of signals, C, D, E, F, G, H, K, erected at convenient distances, or on remarkable points of the country; and the angles which the signals make with each other determined by a theodolite or other appropriate instrument. The sides A C and B C are then deduced from the measured base A B, and thence successively the sides of the other triangles. In this manner the whole distance between the stations which form the terminal points of the arc is determined by a series of trigonometrical calculations. The reductions for differences in the levels of the signals must next be applied, and also for their altitude above the level of the sea; and it is obvious that these reductions cannot be made without having at least an approximate knowledge of the dimensions of the earth, and without making some hypothesis respecting its figure, though the dimensions and figure of the earth are elements that can only be deduced from the measurement and comparison of degrees.

From this general description it will be readily inferred that the measurement of terrestrial degrees depends on astronomical operations of very great nicety, on most careful triangulations, and the exact measurement of a base line. To such perfection have we now arrived, that the greatest *possible* error in the base line on which the correctness of our own Ordnance Survey depends—a line between seven and eight miles long—is supposed not to exceed *two inches*!

In the year 1735, the Academy of Sciences of Paris, to decide the important question of the spheroidal form of the earth, resolved that two arcs of meridian, the one at the equator and the other as near the pole as possible, should be measured with all the accuracy which the improved state of astronomy admitted of. Accordingly, Bouguer, Godin, and Condamine were despatched to Peru; Maupertuis, Clairaut, Lemonnier, and some other associates, to Lapland—for the execution of this purpose. The latter party accomplished their mission, and returned to Paris within sixteen months; Bouguer and his companions had to contend with great difficulties and hardships, and were detained not less than ten years. The result was that the length of the degree of the meridian at the equator, reduced to the level of the sea, was found to be 56,753 toises, or 362,912 English feet; and in Lapland, under the parallel of 65½°, to be 57,437 toises, or 367,286 feet, exceeding the former by 684 toises.

Since these memorable expeditions, several arcs of meridian have been measured in different countries, and all the results concur in proving that the degrees increase in length as we proceed from the equator to the pole, agreeably to the theory of hydrostatic equilibrium, which requires an accumulation of matter in the equatorial regions of the earth, in order to counterbalance, by its attraction, the effect of the centrifugal force of rotation.

The following are the most important of these measurements:—

No.	Meridional Arcs	Amplitude or Length of Arc	Latitude of Middle Point	Length of Degree in English Feet
		° ′ ″	° ′ ″	
1	Arc measured by Bouguer, recomputed by Delambre . . .	3 7 3	1 31 0S	362,809
2	First Arc measured in India by Col. Lambton, from Trivandeporum to Paudree. .	1 34 56	12 32 21N	362,988
3	Second Indian Arc by Col. Lambton and Capt. Everest, from Punnae to Kulliampoor . . .	15 57 39	16 8 22	363,040
4	French Arc from Dunkirk to Formentera by Mechain and Delambre . .	12 22 12	44 51 0	364,644
5	English Arc from Dunnose to Burleigh Moor .	3 57 13	52 35 45	365,032
6	Arc measured in Hanover by Gauss, from Gottingen to Altona	2 0 57	52 32 17	365,301
7	Arc measured in Lithuania by Struve, from Jacobstadt to Hockland . .	8 35 5	58 17 37	365,377
8	Arc measured in Sweden by Svanberg, from Maltorn to Pahtawara . . .	1 37 20	66 20 11	365,697

More recent measurements in India have been executed by Sir George Everest with extraordinary care, and with instruments sufficient to insure the utmost attainable accuracy. Three base lines, each exceeding seven miles in length, were measured with a compensating apparatus similar to that invented and used by General Colby for the measurement of the base of the trigonometrical survey of Ireland. The terrestrial angles were observed with theodolites of three feet in diameter, and the two celestial arcs were determined by observations of stars made simultaneously at both extremities of each arc with altitude and azimuth circles, having vertical circles also of three feet in diameter. The final results were as follows: The amplitude of the celestial arc corresponding to the northern section, Kaliana to Kalianpur, was found by the mean of all the observations to be 5° 23′ 37·051″; and that of the southern, Kalianpur to Damargida, 6° 3′ 55·973″. The terrestrial distances on the meridian, computed from the mean of the two bases (near the extremities of each section), and reduced to the level of the sea, were 1,961,157·117 feet and 2,202,926·196 feet respectively. Hence the length of the meridional degree, as found from the northern section, is 363,606 feet, or 68·865 miles, at the middle latitude 26° 49′, and as found from the southern section is 363,187 feet, or 68·785 miles, at the mean latitude 21° 5′. The comparison of the two arcs, without reference to other measures, gives an ellipticity to the terrestrial spheroid of 1 ÷ 192, considerably greater than the ellipticity deduced from the results (properly combined) of all the principal operations of the same kind executed in different countries, namely 1 ÷ 300, and consequently indicating some irregularity either in the curvature of the earth at that locality, or in the density of the superficial strata, giving rise to local attraction at the terminal stations.

The 29th vol. of the *Memoirs of the Royal Astronomical Society* contains an important paper by Captain Clarke, in which all the most important geodesical measurements are examined. The final result, as given in Sir John Herschel's *Astronomy*, 7th edition, is as follows:—

'The earth is not exactly an ellipsoid of revolution. The equator itself is slightly elliptic, the longer and shorter diameters being respectively 41,852,864 and 41,843,096 feet. The ellipticity of the equatorial circumference is therefore $\frac{1}{4283}$, and the excess of its longer over its shorter diameter about two miles. The vertices of the longer diameter are situated in longitudes 14° 23′ E. and 194° 23′ E. of Greenwich, and of its shorter in 104° 23′ and 284° 23′ E. The polar axis of the earth is 41,707,796 feet in length, and consequently the most elliptic meridian (that of longitude 14° 23′ and 194° 23′) has for its ellipticity $\frac{1}{287 \cdot 5}$, and the least so (that

of longitude 104° 23′ and 284° 23′) an ellipticity of $\frac{1}{308 \cdot 3}$.

The following table shows the length of a degree of latitude at every tenth degree:—

Latitude	Length of Degree in English Feet	Latitude	Length of Degree in English Feet
0	362,734	50	364,862
10	362,843	60	365,454
20	363,158	70	365,937
30	363,641	80	366,252
40	364,233	90	366,361

Degree of Longitude. On the earth, a degree of longitude is a degree of the equator, or of any of its parallel circles. If the earth is a regular spheroid of revolution, the circles parallel to the equator, and consequently the degrees of those circles, must diminish regularly as their distance from the equator increases, according to a law derived from the nature of the ellipse. Hence, if we know the measured lengths of a degree of two or more small circles in different latitudes, we are in possession of data sufficient to determine the diameters and ellipticity of the earth. The measurement of degrees of longitude, therefore, in reference to the determination of the earth's figure, is of equal importance with the measurement of degrees of the meridian, and has accordingly been executed in various instances. The geodetical operations required in the one case are the same as in the other; but on account of the great difficulty of determining the astronomical longitudes with the necessary accuracy, the results have never been regarded as equally satisfactory. At the present moment an arc of longitude embracing nearly 70° is being measured between Valentia in Ireland, and Orsk in Russia. This is far in advance of anything previously accomplished, and the rapid extension of telegraphic communication may soon enable us to eclipse even this splendid conception. The following table shows the length of a degree of longitude at every tenth degree of latitude:—

Latitude	Degree of Longitude in English Feet	Latitude	Degree of Longitude in English Feet
0	365,152	50	235,171
10	359,640	60	183,029
20	343,263	70	125,254
30	316,493	80	63,612
40	280,106	90	0

Degrees. In Music, the small intervals of which the concords or harmonical intervals are composed.

Dehiscent (Lat. dehisco, *I gape*). In Botany, a term applied to those fruits which separate regularly round their axes, either wholly or partially, into several pieces. The act of thus splitting is called *dehiscence*.

Dei Gratia (*by the grace of God*). A Latin formula, usually inserted in the ceremonial description of the title of a sovereign. It was used originally by the clergy.

Deification. [APOTHEOSIS.]

Deilephila (Gr. δείλη, *evening*, and φιλέω, *I love*). A subgenus of hawk-moths (*Sphingidæ*) belonging to the crepuscular or evening tribe of Lepidopterous insects. They are characterised by wings entire and acute: antlia rather elongated; antennæ short, and clubbed in the male. One species, *Deil. Celerio*, feeds upon the vine.

Deinotherium (Gr. δεινός, *terrible*, and θηρίον, *beast*). The name of a fossil genus of gigantic Pachyderms, chiefly remarkable on account of its enormous tusks, which projected downwards from the lower jaw instead of the upper, as in the elephant and walrus.

Deism or **Theism** (Lat. Deus, Gr. Θεός, *God*). Belief in the existence and attributes of God, coupled with disbelief in any express revelation of His will. There exist various shades of opinion among Deists, which are pointed out in Clarke's work on the *Attributes*; but general usage has assigned this word a meaning synonymous with *sceptic* or *freethinker*: hence it is regarded as a term of reproach. In its original acceptation, *theist* was directly opposed in meaning to *atheist*; but these terms are now frequently, though incorrectly, employed without distinction to designate an *unbeliever in Christianity*.

Déjeuner (Fr. *breakfast*, from Lat. de, and jejunium, *abstinence from food*). A term naturalised in almost all the languages of modern Europe, signifying the morning meal. It may be remarked, however, that in France itself this term is rapidly losing, if indeed it has not already lost, its original acceptation, being used as synonymous with the English *luncheon*.

Del Credere Commission. In Mercantile Law, a term derived from the Italian (credere, *to trust*), which denotes a commission granted by a merchant to a factor to dispose of goods; the factor, for the consideration of an additional percentage, agreeing to guarantee the solvency of the purchaser. [FACTOR.]

Delabechea (in honour of Sir H. T. de la Bêche). To this genus of *Sterculiaceæ* belongs the Bottle-tree of Australia, *D. rupestris*, a tree remarkable for the curious form of its trunk, which is bulged out in the middle in the form of a barrel, and abounds in a mucilaginous or resinous substance, resembling gum tragacanth. The wood is remarkably soft, and a clear jelly is obtained by pouring boiling water upon shavings of it. The leaves are sometimes lance-shaped, sometimes digitate, and the flowers altogether inconspicuous.

Delegates, Court of. Formerly the highest ecclesiastical court of appeal in England: in ordinary cases composed of three common law judges and three civilians; in special cases a fuller commission was sometimes issued. In case of a division of opinion, or where no common law judge was in the majority, a commission of adjuncts was issued. Appeal lay to it from the archiepi-

scopal courts. Its powers are transferred by 2 & 3 Wm. IV. c. 92 to the privy council.

Delegation (Lat. delegatio, from delego, *I assign*). In the Civil Law, the act by which a debtor transfers to another person the duty to pay, or a creditor makes over to a third party the right to receive, payment.

Delft Ware. A coarse species of porcelain, originally manufactured at Delft in Holland, whence its name.

Delian Problem. [Duplication of the Cube.]

Deliquescence (Lat. deliquesco, *to melt down*). When certain saline substances are exposed to air, and absorb a sufficient quantity of water to moisten or dissolve them, they are said to *deliquesce*.

Delirium Tremens (Lat.). A disease of the brain, resulting from the excessive and protracted use of spirituous liquors; it is therefore almost peculiar to drunkards. It begins with excessive irritability, loss of sleep, frightful dreams and visions, and a multiplicity of the ordinary delusions of insane persons, ending in confirmed and often furious madness. The hands are usually, but not always, tremulous. By careful treatment, and more especially by the judicious use of opium, patients have recovered from this disease; but, for obvious reasons, it is difficult to manage, and subject to relapses. Bleeding should in almost all cases be avoided.

Delitescence (Lat. delitescere, *to lie hid*). In Surgery, when a tumour very suddenly and unexpectedly subsides, it is said to terminate in *delitescence*.

Delphi, Oracle of. So called from Delphi, in Phocis, the most famous of all the oracles of Apollo. At this place certain exhalations, issuing from a cavern, threw all who approached it into convulsions. The responses were delivered by a priestess, called Pythia, who sat upon a tripod placed over the mouth of this cavern, and after having inhaled the vapour, gave utterance to the wished-for predictions, either in verse or prose, which were then interpreted by the priests.

From its favourable position this oracle came to be consulted, not only by the Greeks, but even by the neighbouring nations; and thus the temple was enriched by an incredible number of valuable presents and splendid monuments. Hence this sacred repository became frequently an object of plunder. Still the oracle continued to utter its responses long after the seat of empire had been transferred from Greece to Rome; and it was only when Constantine the Great removed the sacred tripods to adorn the hippodrome of his new city, that the responses ceased to be delivered. [Oracle.]

Delphin. In Bibliography, a name given to the edition of the Latin classics, prepared and commented upon by thirty-nine of the most famous scholars of the day, at the suggestion of Louis XIV., for the benefit of the young Dauphin (in usum Delphini) under the superintendence of Montausier his governor, and his preceptors Bossuet and Huet.

Delphinia. A vegetable alkaline base, obtained from the seeds of the *Delphinium Staphisagria*, or stavesacre.

Delphinic Acid. [Delphinin.] A fat-acid obtained by saponification from the oil of the *Delphinus* or porpoise: it has also been termed *phocenic* acid. It exists in the vegetable kingdom in the berries of *Viburnum Opulus*.

Delphinite. A variety of *Epidote* from Dauphiny.

Delphinium. A genus of *Ranunculaceæ* which yields many favourite garden flowers. The seeds of Stavesacre, *D. Staphisagria*, are used for destroying vermin; and an ointment prepared from them is sometimes employed in cases of rheumatism and neuralgia. This plant is an annual, with white-veined palmately divided leaves, and loose racemes of greyish flowers, the upper sepal of which, as in the rest of the genus, is spurred.

Delphinus (Lat.). The *Dolphin*, one of the ancient constellations of the northern hemisphere.

Delphinus. This term is restricted in modern Zoology to those species of Cetacea which have teeth in both jaws, all simple, and almost all conical. They are the most carnivorous in proportion to their size. The Linnæan genus *Delphinus* is now subdivided into *Hyperoodon*, of which the great bottle-nose dolphin is the type; *Delphinapterus*, represented by the beluga; *Phocæna*, represented by the common porpesse; and *Delphinus* proper.

Delta. The triangular expanse of mud (resembling the fourth letter of the Greek alphabet, Δ) formed at the mouths of certain rivers. Deltas commence at the point at which waters laden with mud first met the sea in times long past, and after gradually widening, owing to the mud deposited, have ultimately attained their present dimensions. It is essential to the nature of a delta that the stream should traverse the accumulations it has brought down by many channels, and it is almost a necessity that the fresh water should gradually become more and more sluggish in its movements, and thus leave behind it all, even the finest, of the mud particles it has conveyed from the mountains where the river takes its origin.

Among the largest deltas are those of the Ganges, the Mississippi, the Nile, the Rhône, the Danube, the Po, the Rhine, &c. They occur, also, not only in the sea where fresh water meets the salt water, and is checked in its onward path by the tides, but in lakes, the accumulation protruding as a tongue beyond the point at which the river enters the lake.

The most usual form of delta is that presented in the low flat land at the mouths of the Nile and the Rhine. In some cases the river does not appear to have pushed itself forward beyond the coast line; but in the gulf of Mexico,

where the tides are small, the Mississippi has advanced itself forward far beyond the coast line and protrudes many miles. The Nile has also projected its delta far beyond the original coast line of the Mediterranean.

The actual advance of some of the European deltas can be measured by comparing the existing state of things with historical documents. Thus the Po and Adige form a delta, which for the four centuries from 1,200 to 1,600 advanced at the rate of twenty-five yards a year, but which, owing to changes that then took place, has since advanced at the rate of seventy yards a year.

The delta of the Mississippi actually protruding from the coast line, is not less in area than the whole of Ireland; but the advance is not now more than a mile in a century. The deltas of the Nile and the Rhine have certainly increased enormously within the historic period. The delta of the Ganges is already double that of the Nile, its head commencing 220 miles from the sea, and its base line measuring 200 miles. Islands are formed and destroyed in it with extreme rapidity, some of them many miles in extent having risen into existence within the observation of man. The depth of the mud is at least 400 feet. The delta of the Rhône is also very large and deep.

Deltoid (Gr. δελτοειδής). Of the shape of the Greek letter *delta*, Δ. The term is used in Anatomy and Botany.

Deluge (Lat. diluvium). In the 1656th year after the creation (according to ordinary chronology), in the 600th year of the life of Noah, and on the 17th day of the second month, the waters began to rise upon the earth. They appear to be represented as swelling upwards by some upheaving force, and descending also in continual rain for forty days and nights. All the mountains 'that were under the whole heaven' were covered; 'all flesh perished that moved on the earth,' with the exception of Noah and his family, and the animals which entered with him into the Ark. The waters remained 150 days; and then 'returned from off the earth continually:' and the Ark rested on Ararat on the seventeenth day of the seventh month; and on the first day of the first month of the following year 'the face of the ground was dry,' but not completely drained of the water for nearly two months longer. Such is a concise abridgement of the account of this catastrophe given in Gen. vii., viii.

The belief in the destruction of mankind by a deluge in the earliest times, and of the escape of one family under circumstances resembling those recorded respecting Noah, is a remarkable feature in the traditions of many nations. The Fo-ki of the Chinese, the Satyavrata of the Indians, Xisuthrus or Seisithrus among the Assyrians, Deucalion and Ogyges among the Greeks—all more or less resemble the patriarch of the book of Genesis: even the Mexicans had their traditional deluge. No such event, however, is noticed in the traditions of the ancient Egyptians.

The tradition that a deluge or a torrent of water has, at a comparatively recent period of the earth's history, swept over the whole surface of the earth and destroyed previously existing landmarks, was at one time thought to be confirmed by geological investigations. It is now certain that no evidence exists of any such event.

Partial deluges, on the other hand, not only may, but must have occurred; for we have unmistakable proof that many large natural reservoirs have been suddenly tapped, and their contents let loose upon low lands of enormous extent, and it is not impossible that one of these events may have been recent enough to justify the tradition that man was then on the earth, and narrowly escaped destruction.

The marks of a universal deluge, had such an event occurred, must have been evident in the valleys, caverns, and other places into which water would enter, and floating objects would be drifted, but from which an exit was difficult. Such localities contain various accumulations, but the mode in which the deposits occur proves clearly that the action of the water that moved them was not diluvial. Many successive events must have combined before even the latest changes of the earth's surface were brought about, and these changes all seem to have been gradual, and to have involved slow elevation and depression of very large areas.

Demagogue (Gr. δημαγωγός). One who directs or leads the people in political matters. In its original acceptation it was considered an honourable designation; but it is now almost invariably used in a bad sense. The oldest and most satirical of all portraits of the demagogue is traced by Aristophanes in his play of the *Knights*, in the character of Cleon. (Grote's *History of Greece*, part ii. chap. ix.)

Demand. In Political Economy, that mutual desire for services or utilities which tends toward completion in an act of exchange. Demand is commonly said to be relative to supply, but in reality demand is reciprocal to it. The measure of demand is found in the fluctuations of price or money value, though, in effect, the satisfaction of supply by money applies, as a rule, only to the demand for small articles, and in internal trade. In international trade, goods are exchanged against goods, imports against exports, money being rarely used.

It is the custom for political economists to qualify the term *demand* by the addition of the word *effectual;* for it is plain that a strong demand may exist without the power of proffering any desirable object in return. But if it is remembered that all economical theories originate in the interpretation of acts of exchange, it will not be necessary to make the limitation. A mere desire for objects has no economical significance, but that desire only which originally contemplates a reciprocal service or benefit.

The intensity of demand, and its consequent effect on prices or values, will be proportional to the necessity which exists for satisfying the

demand. Hence different rules will apply to the increase of price consequent on enlarged demand or straitened supply in articles of voluntary use, and to the same increase of price when affecting commodities of necessary use. The demand in the latter class of commodities is constant, and a deficiency in supply will not or cannot be met by abstinence, except to a very limited amount, whereas any considerable deficiency in the supply of articles of voluntary use is to some extent obviated by economy. Prices will therefore increase in different ratios according to the degree in which the objects demanded are necessary, convenient, or voluntary.

This law of the increase of price is seen most clearly in the effect of insufficient supply on the price of food. Suppose, for instance, that the amount of corn consumed by a people in average years is represented by ten million quarters; and that from some cause (for example, a wet harvest) the supply falls short of the average consumption by two millions of quarters; and further, that when the supply is commensurate with the ordinary demand, the price is sixty shillings a quarter. The consequence of the scarcity would not be that the eight millions would sell for thirty millions of sovereigns—the price, that is, of ten millions in average years—but for forty, fifty, or sixty millions; for the commodity being a necessary of life, and one which, when abundant, is not used in excess, everything which tends to diminish its quantity provokes a more urgent demand for equal participation in the remainder. It is easy to see, therefore, how important it is that every facility should be given for the supply of food, since the contingency of great fluctuations in the money price of food will be diminished as the area of supply is extended.

The same law applies, in a modified form, to the demand for a great convenience—as, for instance, the raw material of necessary clothing, as cotton and wool. Here a scarcity will not represent so aggravated a rise as ensues from a scarcity of food, but it will be sufficient to enhance the money value of the insufficient quantity to a larger amount than that of the aggregate price of a full supply. A striking example of this will be found in the recent rise in the price of these raw materials; the sole cause, apparently, of the enhanced cost residing in the cessation of supply from the region which contributed one of these commodities in the greatest quantity.

Where, however, the commodity is one of voluntary use, a considerable scarcity may occur without any great increase of price. The vine, for instance, has for several years been affected by a serious disease. But the rise in the price of wine has not been commensurate with the deficiencies of several vintages, and is much more to be assigned, where it has occurred, to increased demand consequent on greater power of expenditure, than to any other cause. On the other hand, the increase in the price of meat has not been consequent upon diminished supply, but on a greatly enlarged demand, the demand arising from the marked improvement in the condition of some among the operative classes; an improvement partly due to the actual enlargement of their money wages, partly to the remission of taxation, and much more to the low price of bread consequent upon the results of free trade in corn.

It is necessary to observe that demand may exist very urgently, and yet supply be not forthcoming. We may demand commodities, but the capital necessary to satisfy that demand by production may not exist, or may not easily be diverted from other occupation. When, however, the spread of sound economical principles has led governments to give all security which law can give and confirm to advances of capital for industrial occupations in communities where capital is scanty or dear, the interval which always must exist between increased demand and supply from new quarters will be proportionately diminished. The fact that very different rates of interest prevail in countries which are geographically near and are politically distant, is a barbarism which indicates municipal jealousy, insufficient legislation, or partial and unfair administration.

Demarcation. A term used to designate the line or boundary by which one object is separated or marked off from another. The word was first introduced in 1493, when Pope Alexander VI., in order to put an end to the disputes between the crowns of Spain and Portugal relative to their Indian discoveries and conquests, by virtue of his pontifical authority drew through the ocean an imaginary line, by which the dominions of both parties were defined; and thus originated the expression *line of demarcation.*

Demesne (Lat. terra dominicalis). In Law, originally that portion of the lands belonging to a lord which was held in his own occupation. Hence it is sometimes used to distinguish those parts of a manor which the lord has in his own hands, or those of lessees at rack-rent, from those which are in the hands of freeholders and copyholders. [Ancient Demesne.]

Demeter (Gr.). This goddess, in the *Theogony* of Hesiod, is a daughter of Cronos and Rhea, and the mother of Persephonê [Proserpine] and Dionysus [Bacchus]. The most prominent myth connected with her name is the rape of Persephonê, who is seized by Hades while gathering flowers in the fields of Enna. In the search for her child, Demeter comes to Eleusis in Attica; and the legend thus accounts for the institution of the Eleusinian mysteries. The name Demeter has generally been supposed to be the same as γῆ μήτηρ, Mother Earth; but by Professor Max Müller it is connected with the Sanscrit Dyâvâ Mâtar, the Dawn. (*Lectures on Language*, second series, p. 517.)

Demi (Fr.). A word signifying *half*, frequently used in the composition of English words, being equivalent to the Latin *semi*.

Demiditone (Gr. δίτονος). In Music, a minor third. [Third.]

Demigods. A general appellation of the inferior divinities of Greece and Rome, more particularly of such of the mixed offspring of divinities and mortals as were afterwards deified.

Demilune. In Fortification. [RAVELIN.]

Demiquaver and Demisemiquaver. In Music, notes equal in duration to half a quaver and semiquaver respectively.

Demitint. In Painting, a tint representing the mean or medium between light and shade, or the gradation between one tint and another; by some called a *half-tint*.

Demiurgus, Demiurge (Gr. δημιουργός). In the original sense of the word, as used by classical authors, an artificer employed in ordinary handicraft. In the language of Platonist writers, it denotes an exalted and mysterious agent, by whose means God is supposed to have created the universe. Hence the Demiurgus, or Logos, as the same imaginary agent is termed in the *Timæus* of Plato, is identified by the Platonising Christians with the second Person in the Trinity.

Democracy (Gr. δημοκρατία, from δῆμος, *people*, and κρατέω, *I govern*). A government is usually termed a democracy in which the whole of the people, or a large proportion of it, exercises sovereignty either directly or by representatives. According to some political writers, the term is strictly appropriate only where 'a majority of the adult males' share in the government. In Aristotle's view of governments, democracy is a perversion of the imaginary system, which he terms Politeia, or commonwealth par excellence; in which the majority are supposed to govern for the good of the whole, while in democracy they govern for their own. [REPUBLIC.]

Demogorgon. In Mythology, a mysterious being, who was an object rather of terror than of worship: hence in the *Paradise Lost* (book ii.) Milton speaks of

> ——— the dreaded name
> Of Demogorgon.

The Demogorgon is also introduced by Shelley, under a somewhat different aspect, into his drama *Prometheus Unbound*.

Demoiselle (Fr.). In Zoology. [GRUIDÆ.]

De Moivre's Theorem. An important relation discovered by De Moivre (*Miscellanea Analytica*), and expressed by the formula,

$$(\cos\theta + \sqrt{-1}\sin\theta)^n = \cos n(\theta + 2r\pi) + \sqrt{-1}\sin n(\theta + 2r\pi),$$

where r is any integer. The demonstration is simple, and is given in all treatises on trigonometry. It will be sufficient to add here that the formula is true for all values of n and θ, and that for integral values of n, positive or negative, it assumes the simpler form

$$(\cos\theta + \sqrt{-1}\sin\theta)^n = \cos n\theta + \sqrt{-1}\sin n\theta.$$

When n is fractional, equal to $\frac{p}{q}$, the q different values which the expression on the left then possesses are obtained by giving to r the successive values, 0, 1, 2 . . . $q-1$; every other value of r will give to the expression on the right one or other of these q values; thus s being less than q, $r=mq+s$ and $r=s$ will lead to the same result, whatever positive or negative integer m may represent.

Demon. [DEMONOLOGY.]

Demoniacs. Persons possessed by or under the influence of demons or devils. The idea of demoniacal possession was very ancient among the Oriental nations.

Demonology (Gr. δαίμων, and λόγος, *discourse*). The belief in an intermediate race of beings, between deity and humanity, has been a prevalent feature in almost every popular creed; and all tradition or speculation respecting it may be said to fall under the general term of *demonology*. Among the early Oriental nations, especially the Persians and Egyptians, the science of astronomy appears to have been essentially connected with this branch of superstition; the heavenly bodies were honoured as demons or celestial intelligences. This ancient belief appears to have had much influence on the Jewish rabbinical writers; and out of it, connected with what is revealed to us in the Old Testament of the existence and attributes of angels, they framed their peculiar mythology.

The Greek word δαίμων, *dæmon*, is said to be connected with δαήμων, *knowing* or *intelligent*. In Homer there is scarcely any distinction between gods and demons. A generic difference between them is first brought out in the Hesiodic poem entitled *Works and Days*. In this poem, the men of the golden age have become guardian terrestrial demons, for the benefit of mankind. Those of the silver age are the blest of the under-world, and so not strictly demons at all. But it was easy to treat them as demons of a malignant character; and, as soon as this was done, the fabric of demonology was complete. The Hesiodic heroes are quite different from the demons, being the men who fought before Thebes and Troy, and gave a name to the heroic age. Thales is said to have defined more accurately the difference between gods, heroes, and demons properly so called; and in Plato's theology the demons occupy an important place—as closely watching over, directing, and recording the actions of mortals. By later writers they were divided into many classes: some good, some bad (Agathodæmon, Cacodæmon, from ἀγαθός, *good*, and κακός, *bad*); some ministers of punishment and revenge, some freeing from evils already befallen (λύσιοι), some warding off their approach (ἀλεξίκακοι), &c. It was in Egypt and Syria, under the Ptolemies and Seleucidæ, that the Grecian philosophy and mythology came in contact with those of the Rabbis; and from that union a new mixed system of demonology took its origin. Hence, in the Greek of the New Testament, the word δαιμόνιον is taken, without addition or qualification, as an evil spirit, and rendered by our translators 'devil.'

Analogous to the demons of the Greeks were the genii of the Romans; but there were

peculiar and characteristic features about the belief in the latter which show it to be of a different origin, possibly derived from the Etruscans. The genii of the Romans were an innumerable host of spirits: every man, house, or city had an attendant genius. The genius of every mortal is mortal as himself; accompanies him into life, and conducts him in all its vicissitudes. In this sense, the genius was a benignant companion: to enjoy the good things of life is represented as 'indulging' or gratifying the genius; abstaining from them, as 'defrauding' him. Wine and flowers are appropriate offerings to him. But he is also termed *vultu mutabilis, albus et ater*: he is the companion of the mischances as well as the pleasures of life; unless, as the difficulty appears sometimes to have been solved, the individual had his *pair* of genii, good and bad. The Etruscans represented the evil genius as a dark and frightful figure, attending a mortal on one side, who is protected or followed on the other by a child or youth—the usual emblem of the good genius. The genius is often represented on vases and in ancient paintings as a winged figure; and a genius holding a torch downwards is the emblem of death.

The demons of the middle ages were simply fallen angels or devils, according to the sense of the word in the New Testament; and hence demonology, in the language of modern writers, generally signifies the history of the supposed nature and properties of such evil spirits, and of the modern superstition respecting compacts between them and mankind. [MAGIC; WITCHCRAFT.]

Demonstration (Lat. demonstratio, from demonstro, *I show*). This term was used by the old writers to signify any manner of showing either the connection of a conclusion with its premisses, or that of a phenomenon with the asserted cause; but it now means, in philosophical language, only that process by which a result is shown to be a necessary consequence of the premisses from which it is asserted to follow, on the supposition that those premisses are admitted, either as matter of fact, or of intuitive evidence, or of previous demonstration.

DEMONSTRATION. In Military language, any operation performed with a view to deceive an enemy.

Demos (Gr.). In ancient History, a district or tract of land, probably from δᾶ, the Doric form of γῆ, the earth. The Attic Demi answered to our townships or hundreds; their union into one people, with Athens as their centre, is attributed to Theseus. (Thucydides ii. 15; Grote's *History of Greece*, part ii. ch. x.)

Demotic Characters. [HIEROGLYPHICS.]

Demulcents (Lat. demulceo, *I soothe*). Medicines which sheathe and defend sensible parts from the action of irritating matters; they are chiefly mucilaginous substances, such as gum, starch, &c.

Demurrage. In Mercantile Law, the delay which a merchant makes in loading or unloading a ship, beyond the time specified in his charter-party, or other agreement with the owners; in which it is usually stipulated that he shall pay at a certain rate per diem for such extra time, which payment is also termed *demurrage*.

Demurrer (from the Lat. demoror, *I delay*). In Law, an issue between plaintiff and defendant on matter of law. It confesses that the facts are true as stated by the opposite party, but denies the legal consequences inferred by the opposite party from these facts. Demurrers are either general or special. [PLEADING.] Demurrers in equity are of the same nature with those at law. Demurrer may be also to an indictment in criminal cases.

Demy. [PAPER.]

Denarius (Lat.). A Roman silver coin worth ten asses originally, and afterwards considered equal to eighteen asses, when the weight of the latter coin was reduced to one ounce. Originally the denarius was $\frac{1}{100}$ of a pound of silver, but its weight varied. Its value is considered equal to 8*d*. of English money. There was also a gold denarius equal in value to twenty-five silver denarii.

Dendrerpeton (Gr. *δένδρον, tree*, and *ἑρπετόν, a reptile*). This genus of Ganocephalous reptiles was discovered by Sir Charles Lyell and Mr. Dawson in the coal strata of Nova Scotia, in the hollow of the trunk of one of the gigantic *Sigillariæ*. It bears close affinity to the genera HYLONOMUS and ARCHEGOSAURUS.

Dendritic (Gr. *δένδρον*). A mineral is said to have dendritical markings when it contains internally, or is superficially covered with, filamentary forms, like those of moss, ferns, trees, &c. The Moss Agate, and the variety called Mocha Stone, afford familiar examples.

Dendrodoa (Gr. *δένδρον*, and *ᾠόν, an egg*). The name of a subgenus of Ascidians or fixed tunicated Molluscs, suggested by the ramified form of the ovarium; but this structure is not peculiar to the species included in the genus so designated.

Dendroid (Gr. *δενδροειδής*). Tree-like; that is to say, divided into branches like the head of a tree. This term is only applied in the case of small plants.

Dendromys (Gr. *δένδρον*, and *μῦς, a mouse*). A South African genus of Rodentia, nearly allied to the true mice, but differing in the habits of the species, which frequent the branches of trees, in which they construct their nest and bring forth their young.

Dendrophis (Gr. *δένδρον*, and *ὄφις, a serpent*). A genus of harmless serpents of the great family of Colubers, remarkable for their long and slender body.

Denizen (derivation uncertain, but it may perhaps be formed from 'deins né,' *born within*, the old French form being *deinzein*). In Law, an alien born, who has received *ex donatione regis* letters patent to make him an English subject. He may take lands by purchase and devise; but cannot enjoy offices and trusts, &c., or receive a grant of lands from the crown.

Denominator (Lat. denomino, *I name*). A term used in Arithmetic, in speaking of frac-

tions, to denote the number of parts into which the unit or whole is divided. Thus, for example, in the fraction $\frac{7}{12}$ (seven twelfths) of a foot, 12 is the denominator, and indicates that the unit or one foot is divided into 12 equal parts; and 7, the numerator, shows how many of these parts are to be taken.

Dénouement (Fr.). A term signifying the developement of the plot or story in a novel or play, and in short in every department of literature.

Density (Lat. densitas, from densus, *thick*). This term is used in Physics to denote the quantity of matter which a body contains under a given or determinate surface; for example, a cubic foot. The quantity of matter in any body is called its *mass*, and is measured by the weight of the body, to which it is always proportional. Hence the density of any body is great in proportion as its weight is great and its volume small; or, the density of bodies is directly as their mass, and inversely as their volume. It follows also from the definition, that if two bodies have the same volume, their densities are directly as their masses or weights; and that if two bodies have the same mass or weight, their densities are respectively in the inverse ratio of their volumes. The term is generally used as synonymous with *specific gravity*.

Dental Formula (Lat. dens, *a tooth*). A notation used to signify the number and kind of teeth of a mammiferous animal, and usually forming the main element in its generic character. Thus the cats, or genus *Felis*, are characterised by incis. $\frac{6}{6}$; canin. $\frac{1}{1}$, $\frac{1}{1}$; præmol. $\frac{2}{2}$, $\frac{2}{2}$; mol. $\frac{2}{1}$, $\frac{2}{1} = 30$; which signifies that they have six incisores in both the upper and the lower jaw; one canine tooth on each side of both jaws; two præmolares, or false molares, on each side of each jaw; two true molares on each side of the upper, and one on each side of the lower jaw. The dental formula of man is: incis. $\frac{4}{4}$; canin. $\frac{1}{1}$; præmol. $\frac{2}{2}$, $\frac{2}{2}$; molares, $\frac{3}{3}$, $\frac{3}{3} = 32$.

Dentalium (Lat. dens). A genus of Molluscs inhabiting elongated univalve shells, resembling an elephant's tusk in miniature, whence the name.

Dentate (Lat. dentatus, *having teeth*). In Zoology, the margin of a part of an animal is so termed when it is cut into teeth whose sides are equal, or nearly so.

Dentatus (Lat.). Toothed; applied to the margins of bodies furnished with sharp teeth with concave edges.

Dentes. [TEETH.]

Dentils (Lat. dens). In Architecture, square blocks or projections in the bed mouldings of the cornices of the Ionic, Corinthian, and Composite orders, and occasionally also in the Doric: the term is applied to ornaments in cornices of rooms, which are founded upon the same style of decoration. Their depth should be twice their width; and, according to Vitruvius, the intervals should be two-thirds of that dimension. In the Grecian orders they are not used under modillions; in the Roman orders this arrangement is by no means adhered to, and the modillions and dentals are constantly used in combination; the same remark applies to modern architecture.

Dentinal Tubes (Lat. dens). The subparallel branching tubes which radiate from the pulp-cavity of a tooth at or nearly at right angles with the periphery of the dentine: they have a diameter of $\frac{1}{10000}$th of an inch, at their origin, in the human teeth, and consequently admit only the plasma, or colourless liquor of the blood.

Dentine (Lat. dens). The fundamental and most constant substance or tissue of which a tooth is composed. It consists of an organised animal basis disposed in the form of extremely minute tubes and cells, and of earthy particles, which have a twofold arrangement, being either blended with the animal matter of the interspaces and parietes of the tubes and cells, or contained in a minutely granular state in their cavities.

Dentirostres (Lat. dens, and rostrum, *a beak*). The name of a tribe of Insessorial birds, characterised by having a notch and tooth-like process on each side of the margin of the upper mandible. In connection with this organisation the Dentirostral birds manifest rapacious habits, and prey on smaller and weaker birds. The butcher-birds belong to this tribe.

Dentition (Lat. dentitio). The cutting of the teeth. At birth the teeth consist of pulpy rudiments buried in the gum; and it is not till the third or fourth month that they begin to assume shape and hardness. At this period children generally become fretful; the saliva flows copiously, and they are fond of biting upon anything hard and cold: the gums become turgid: there is more or less fever, frequently a cough; and a rash appears, commonly called the *red gum*. The symptoms generally subside in the course of a fortnight or three weeks, and the child remains tolerably free from uneasiness till the seventh or eighth month, when the gums become tender; and often so much so, at some particular spot, that the slightest touch or pressure produces extreme pain: the gums become more red and swollen, but paler at the upper part, which, just before the tooth appears, becomes blistered. During these periods an increased flow of saliva and a lax state of bowels are favourable symptoms; but where the local irritation is considerable, the gums should be lanced, and any excessive diarrhœa should be cautiously checked: small doses of magnesia, or of chalk mixture with dill water, and occasionally with a little powdered rhubarb, will generally be sufficient for this purpose. When involuntary motions of the jaws and face, or more general convulsions ensue, and are not relieved by the

term is also applied to that portion of a battalion which remains at home when the rest is ordered upon foreign service. The dépôts of several battalions are combined, and form a dépôt battalion.

Depressed (Lat. depressus, part. of deprimo, *I depress*). In Zoology, the whole or part of an animal body is so called when its vertical section is shorter than the transverse.

Depression of Equations. In Algebra, the derivation, from a given equation, of another lower in degree, whose roots are related in a known way to those of the first. This reduction can always be effected, of course, by simple division when one or more of the roots are known; but without knowing the roots beforehand the equation may be depressed: 1st. When some particular relation subsists between two (or more) of the roots; for example, if an equation contain equal roots, these may be found, and the equation reduced by as many dimensions as there are equal roots; 2nd. If two roots of an equation be equal in magnitude, but opposite in sign; and 3rd. If the equation be a reciprocal one, that is to say, such that its form is not changed, by changing x into $\frac{1}{x}$. [EQUATIONS, THEORY OF.]

Depression of the Horizon. [DIP OF THE HORIZON.]

Depressor Muscles. In Anatomy, those muscles which lower the bone to which they are attached, in contradistinction to ELEVATOR MUSCLES [which see].

Deputies, Chamber of (Fr. chambre des députés). The lower of the two legislative chambers in France under the monarchy, from 1814 to 1848. The right of election was latterly in persons of twenty-five years of age paying 200 francs of direct contributions. There were 459 members of the chamber, each elected by a separate electoral college: the election was by ballot. To be eligible to the chamber, the candidate must be thirty years of age, and pay 500 francs of direct taxes. The total number of electors in 1846–7 amounted to 200,000. The duration of the chamber was triennial.

The Chamber of Deputies was divided into nine bureaux: which were renewed every month. To these bureaux questions were referred by the chamber; as well laws proposed by the king or the house of peers as propositions of individual members. The bureaux reported on the question, after separate discussion in each, before the general discussion in the chamber began. Except in case of dissolution, measures commenced in one section passed on to the next in the same stage in which they had been left. The vote on a proposed law was secret, on any other proposition open.

The *coté droit*, *coté gauche*, and the *centres*, formed the three grand divisions of which the Chamber of Deputies was composed. When the three great chambers of the States-General of 1789 were consolidated into one by the designation of the National Assembly, the most distinguished members of the aristocratic and republican parties were in the habit of sitting together, for the purpose of communicating more easily with one another: the former occupied the benches to the right, the latter those to the left of the president's chair; while the centre benches, or those fronting the president's chair, were filled by those who held various intermediate shades and modifications of opinion. This custom remained in force down to the fall of the monarchy, and nothing could exceed the nicety with which each variety of political opinion was grouped in the French representative assembly. The coté droit, or the side to the right of the president's chair, was occupied by those members who inclined to favour the royal prerogative; the coté gauche, on the other hand, was set apart for those who were more in favour of popular ascendency; while those members who, with considerable difference of opinion among themselves, generally supported the ministers, occupied the *centres* (centre droit et centre gauche), which might thus be termed the *ministerial benches*. But it has been judiciously remarked that, 'as in every great political party there are shades of opinion, some being more warm and violent, and others more moderate, discriminating, or cautious, so both the coté droit and the coté gauche were generally subdivided into three sections each. The more zealous royalists took their seats at the outer extremity of their side of the house towards the president, and were styled the *extrême droit*: the ultra-liberals sat on the corresponding seats on the opposite or left side, and were styled the *extrême gauche*.'

Derbyshire Spar or **Fluor Spar.** It is of various colours; and the large nodules, which are peculiar to Derbyshire, are often beautifully veined, and admit of being turned in the lathe into vases and small columns. A fine variety of this spar occurs in Cumberland, in cubic crystals of a pale sea-green colour. The cube is the most common form of the crystals of fluor; but it also occurs in octohedra, some fine specimens of which have been found associated with galena in the mine of Beer Alston upon the Tamar. It consists of fluorine and calcium.

Derelict. In Law, lands left dry by the recession of the sea are so called. Also vessels forsaken at sea.

Derivation (Lat. derivatio). In Etymology. [GRAMMAR; LANGUAGE.]

DERIVATION. The peculiar constant deviation of an elongated projectile fired from a rifled gun. [PROJECTILE; GUNNERY.]

Derivations, Arbogast's. [ARBOGAST'S METHOD OF DERIVATIONS.]

Derived Function or **Derivative.** A term first used by Lagrange in his *Calcul des Fonctions* to indicate the coefficient of h in the developement of a function $F(x+h)$ according to powers of h. It is itself a function of x, and is usually represented by the symbol $F'(x)$. In a similar manner the derived function of $F'(x)$ is termed the *second derived function* of $F(x)$

and denoted by the symbol $F''(x)$. By allowing h to diminish indefinitely, the identity of the derived function and the differential coefficient $\frac{d.F(x)}{dx}$ is at once seen. [DIFFERENTIAL COEFFICIENT.]

Derm (Gr. δέρμα, *skin*). The true or organised layer of the tegumentary covering of animals. It is composed of a close and irregular network of whitish fibres, consisting of condensed cellular tissue, whence it is also termed *corium*, and is everywhere traversed by capillary arteries and veins, absorbents and nerves; and, in the mammalia, by the roots of the hairs and the ducts of the sudorific follicles; it is covered with the *rete mucosum* and *epiderm*. The derm is of considerable thickness in the rhinoceros, hippopotamus, elephant, &c.; whence the name *Pachyderma* applied to the order containing these and allied quadrupeds.

Dermapterans, Dermaptera (Gr. δέρμα, and πτερόν, *a wing*; *skin-winged*). An order of insects dismembered from the *Orthoptera* of Latreille, and including those which have the elytra wholly coriaceous, and always horizontal; the two membranous wings are folded longitudinally, and the tail is armed with a forceps. This order is represented by a single Linnæan genus, viz. *Forficula*, or earwig; insects which are common in damp places, and often found in numbers under stones, and beneath the bark of trees: they do much damage in gardens by preying upon the fruit. The English common name, and also the French, *pierce-oreille*, relate to a habit absurdly attributed to these insects of penetrating the ears.

Dermatobranchus (Gr. δέρμα, and βράγχια, *gills*). A genus of Gastropods, or snails, in which the branchiæ consist, as in *Scyllæa*, of ramified productions of skin.

Dermatology (Gr. δέρμα, and λόγος, *a discourse*). A treatise or history of the skin and its diseases.

Dermestes (Gr. δερμηστής, *skin-eater*). The name of a Linnæan genus of Clavicorn Coleopterous insects, noted for their ravages on dead animal substances, especially the preserved skins of animals, and which are consequently the pests of a museum. The old genus *Dermestes* is subdivided in modern entomology into several subgenera. The *bacon-beetle* (*Dermestes lardarius*) is the type of that to which the term *Dermestes* is now confined.

Dermobranchiates, Dermobranchiata (Gr. δέρμα, and βράγχια; *gills on the skin*). The name of a family of Gastropods, comprehending those which respire by means of external branchiæ or gills, having the form of membranous plates, filaments, or tufts.

Dermohæmal (Gr. δέρμα, and αἷμα, *blood*). The ossified developements of the dermoskeleton in fishes are so called when they form points of attachment for the fins on the ventral or hæmal side of the body. [DERMONEURAL.]

Dermoneural (Gr. δέρμα, and νεῦρον, *nerve*). When the ossifications of the dermoskeleton extend on the neural side of the body, the term *dermoneural* is applied to them. They form the rays of the dorsal, and the upper rays of the caudal fins. Both the *dermoneural* and *dermohæmal* spines are supported on the *interneural* and *interhæmal* spines respectively, which are embedded in the flesh between the *neural* and *hæmal* spines of the endoskeleton.

Dermopteri (Gr. δέρμα, and πτερόν, *a wing*). An order of fishes in which the endoskeleton is unossified; the exoskeleton and vertical fins mucodermoid; no air-bladder. It comprehends the Lancelet (*Amphioxus*) amongst other forms.

Dermoskeleton (Gr. δέρμα, and σκελετόν; *skin-skeleton*). A term applied to the coriaceous, crustaceous, testaceous, or osseous integument, such as covers most invertebrate and some vertebrate animals; it serves more or less completely the office of protecting the soft parts of the body, and as a fixed point of attachment to the moving powers.

Derrick. In Military language, a beam of wood, one end resting on the ground, the other supported at any convenient angle by guys. It gives a point or fulcrum in space to which tackle can be applied for moving heavy ordnance, &c.

DERRICK. In Nautical language, used in a variety of meanings, but chiefly for a tackle used for the purpose of hoisting provisions, stores, guns, &c. in and out of a ship.

The name *derrick* has also been applied to a floating crane, which consists of a large iron pontoon of great width, divided into a number of watertight compartments. From the centre rises a powerful tripod mast, across which turns a yard of great strength. To one arm of the yard are suspended several fourfold blocks, through which pass the chains intended to hoist the weight. From the blocks these chains pass over the top of the mast to the opposite extremity of the yard, and thence to drums worked by powerful steam-engines in the pontoon. When the weight is suspended on one side, the water is admitted as a counterpoise into some of the compartments on the other. The vessel has powers of slow locomotion, and is employed in the lifting of vessels to have their bottoms examined, the placing of machinery, recovery of wrecks, &c. Derricks are extensively used in America. In England the Thames Iron Company constructed one in 1859 which was 270 feet long, 90 feet wide, with a mast 80 feet to the yard and 50 above, the yard being 120 feet long. Two engines enable this machine to lift and carry loads of 1,000 tons.

Dervise (from a Persian word signifying *poor*). The name of certain classes of religious persons among the Mohammedans of Turkey and Asia. They live partly in monasteries, partly alone, either stationary or wandering; and belong to a great variety of orders, of

which there are thirty-two (it is said) within the Turkish empire only. As in most other countries, there has existed in Persia from time immemorial a class of enthusiasts, who, impressed with the conviction that poverty is the only passport to virtue, have voluntarily renounced all the comforts and charities of this life, and devoted themselves to religious exercises. In most instances, however, such enthusiasts have been more famed for the theory than the practice of sanctity; and the dervises do not appear to form an exception to the rule.

Descant (Ital. descanto). In Music, composition in several parts. It is either *plain*, which consists in the orderly placing of many concords answering to simple counterpoint; *figurate* or *florid*, wherein discords are employed; or *double*, where the parts are so contrived that the treble or any high part may be made the bass, and the contrary.

Descartes' Rule of Signs. A theorem by means of which the maximum number of positive or negative roots of an algebraic equation can be immediately ascertained by inspection. The theorem reduces itself essentially to this: *the number of positive roots of an equation cannot exceed the number of variations in the signs of its coefficients, considered in their proper order.* The demonstration is simple, and is given in all text-books on the theory of equations. As an illustration, take the cubic equation

$$F(x) = 3x^3 - 7x^2 + 11x + 4 = 0.$$

Inasmuch as there are but two variations of signs on passing from one extreme term to the other, through the intermediate ones, we conclude that the cubic cannot have more than two positive roots. To ascertain the maximum number of negative roots, it is merely necessary to apply the same theorem to the equation which is obtained from the original by changing x into $-x$. Thus the positive roots of

$$F(-x) = -3x^3 - 7x^2 - 11x + 4 = 0$$

are negative roots of the original cubic, and by Descartes' rule their number cannot exceed one. Descartes' Rule is a particular case of FOURIER'S THEOREM.

Descent. In English Law, if a person die seised in fee-simple, otherwise than as a joint tenant of lands or tenements which he has not disposed of by will, they will descend to his heir. Such seisin is either actual possession, or virtual; as possession by the tenant of a chattel interest, whose possession is always held to be the same with that of the remainder-man, or reversioner, who is to succeed him. If a person have become possessed by purchase of lands or tenements in fee-simple, of which, from the nature of the estate, he cannot obtain seisin (as a remainder expectant on a particular estate of freehold), these likewise descend to the heir in case of his intestacy. It is well known that by the common law of England the rules of descent were different from those obtaining in other countries; that a direct lineal ancestor could in no case inherit from his descendant; that brothers and sisters of the half-blood, i.e. sprung from another mother or from another father, were also excluded from the succession. These rules have now (by 3 & 4 Wm. IV. c. 106) been wholly removed or modified; so that the law of descent recognises in succession the following heirs: 1. The eldest or only son, or his issue. 2. The younger son, or his issue. 3. The daughter, or, if more than one, all the daughters as coparceners and their issue: such issue claiming *per stirpes*, not *per capita*, i.e. claiming only the share of their respective mothers. 4. In default of lineal descendants, the nearest lineal ancestor now succeeds, in preference to any person who would have been entitled to inherit either by tracing his descent through such lineal ancestor, or in consequence of there being no descendant of such lineal ancestor; e.g. a father inherits before a brother, a grandfather before an uncle, &c. 5. In default of father, brothers, or sisters of the whole blood and their issue, then the inheritance devolves on the eldest brother or sister of the half-blood by a different mother, the half-blood following the same rule where the inheritance devolves on the descendant of any other ancestor. 6. On failure of male ancestors on the paternal side and their descendants, female paternal ancestors and their descendants. 7. On failure of these, the mother, her ancestors—first male, then female—and their respective descendants. 8. The half-blood follow always next after any relation in the same degree of the whole blood and his issue, if the common ancestor be a male; next after the common ancestor, if a female: so that the brother by the half-blood on the part of the mother inherits next after the mother. Descent is always traced from the first purchaser, that is, the first who acquired the land otherwise than by descent; but the last owner is presumed to be the first purchaser unless the contrary can be proved. In some particular localities the custom of gavelkind prevails, by which all the sons inherit equally from the father. By the custom of borough English, the youngest son is heir. Bastards and aliens cannot inherit; but a natural-born subject may derive his title (under certain restrictions) through alien ancestors.

DESCENT. In Mechanics, the motion of a body towards the centre of the earth, caused by the attraction of gravity. [ACCELERATION.]

Descriptive Geology. By *descriptive geology* is meant a continuous and definite account of the materials that form the external crust of the earth, including *first* the nature of the rocks or inorganic materials themselves, the mechanical changes that have affected them, and the nature of their organic contents or fossils; *secondly*, the order of arrangement of the materials; and *thirdly*, a distinct and orderly history of the separate formations.

1. *Inorganic Materials of the Earth's Crust.*—

The materials of the earth are certain combinations, for the most part very abundant, of known and common minerals, either such as are presumed in the present state of our knowledge to be elements, or certain definite compounds not easily reduced to their elements. These are called ROCKS, and are of three kinds: they are either clearly derived from water, as loose sands, marls, clays, &c., and are then called AQUEOUS ROCKS; or they are distinctly formed by the action of intense heat, by which they have been melted, and are called IGNEOUS ROCKS; or lastly (and this is far more commonly the case), they have marks of having been originally aqueous, but have since become much changed; these are METAMORPHIC ROCKS. Some of the latter are called CRYSTALLINE ROCKS. These may have been originally aqueous, but have now quite lost all traces of original structure. Each of these kinds of rocks will be found described under its own heading, and to these separate accounts the reader is referred for more detailed descriptions.

Rocks, being the raw materials of the earth, must be studied with reference to their history. To enable the student to familiarise himself with the various facts known concerning them, he must understand the varieties of *structure* [STRUCTURE OF ROCKS] and also the *mechanical position* of the rocks.

All rocks are composed of minerals; but the variety of elementary substances that enter into the great mass of the earth is singularly small. The variety of simple minerals is not large considering the almost infinite combinations of which the number of elements is capable, and in fact the great mass of the matter composing all rocks comes properly under one of the general terms LIMESTONE, SANDSTONE, and CLAY. In addition to the rocks which belong to the aqueous group are GRANITE, LAVA, BASALT, and PORPHYRY of various kinds [IGNEOUS ROCKS, CRYSTALLINE ROCKS], and also GNEISS, MICA SLATE, CLAY SLATE, and others. [METAMORPHIC ROCKS.] Notices of all these will be found in separate articles.

The great modifying force that converts rocks from the simplest mechanical condition through all stages of difference, both apparent and real, is that spoken of by geologists under the term *metamorphism*. By its agency the muds become converted into schists, shales, and slates; the calcareous mud into limestone, or the heaps of accumulated sand into sandstone. Owing to the action of this force, again, further important changes take place in structure and even in the arrangement of the atoms of which the rock is made up; they become *crystalline*, and in so doing occupy smaller space; they contract, and fissures occur in them [MINERAL VEINS]; the cavities and fissures become filled with new combinations of mineral substances and metals, and all appearance of original aqueous origin is lost.

But other causes, more mechanical, have meanwhile produced change. Materials originally accumulated at the bottom of water at moderate depth, are sunk lower and lower, and new materials are heaped upon them. Other parts of the earth's crust are subjected to some upheaving force, and are lifted up either on a line [AXIS OF ELEVATION] or at a point. The overlying masses are thus tilted, and are seen to be inclined to the horizon. [DIP and STRIKE.] Sometimes the rocks dip away from a central line [ANTICLINAL AXIS] or dip towards such line [SYNCLINAL AXIS]. Occasionally they are broken, so that the continuity of a bed is interfered with. [FAULT.]

It is not always the case that the various beds [STRATA] of mineral matter or rock are parallel to one another. [CONFORMABLE STRATIFICATION.] Sometimes the lower beds are much inclined, and the upper less inclined or level. [UNCONFORMABLE.] Occasionally portions of a bed have been carried away or scooped out as by water [DENUDATION], and then horizontal beds being deposited appear unconformable, though really conformable. It will happen by some extraordinary convulsion of nature that rocks are thrown completely over, so as to have the opposite direction from that they ought to have. [REVERSED DIP.] Such phenomena as doubtful or obscure stratification are sometimes met with, and false stratification will occasionally puzzle the young geologist.

Rocks, having generally been formed under water, naturally contain various fragments of vegetable and animal matter. These are ORGANIC REMAINS, and possess a double value as referring to natural history generally, and also to geology. As they belong to ancient races, many of which are now extinct, their study forms a separate science. [PALÆONTOLOGY.] These specimens, being the most remarkable of things *dug up*, are called FOSSILS.

2. *Order of Arrangement of the Materials.*—The classification of rocks [CLASSIFICATION] may be based either on a consideration of the circumstances under which they were found, of the materials of which they are constructed, or of the successive history they teach. The most convenient method in practice is to regard chiefly their fossil contents when they possess evidence of this kind; and thus palæontology has become subsidiary to geology and essential to the geologist.

In arranging rocks by their contents, it has been found convenient to take advantage of certain apparent lines of separation that occur in the countries where geology was first studied, and make these the standard of comparison for the whole world. Of the permanent retention of these standards when the science is more thoroughly advanced, we need not here discuss the probability. Of their present convenience there is no doubt.

Assuming organic remains as the basis of geological classification, all rocks would seem divisible into two classes—fossiliferous and unfossiliferous. This is not, however, so completely the case as might be supposed; for it

not unfrequently happens that rocks deposited mechanically, and not greatly metamorphosed, are yet quite without fossils. Thus relative position in a recognised series comes to be considered as of great value in determining the true position of a rock, or series of rocks, when examined in a new country. Under the head of fossiliferous rocks are thus included many large masses of rocks, in which fossils are rarely or never found.

To understand the further subdivisions of these rocks we must consider the circumstances under which deposits of any magnitude are now being made. There is now, and, so far as we know, there must always have been, a very large area of the earth's surface on which not only no deposits are being made, but which are actually providing the material of the deposits that are going on. The places where accumulation of material takes place are comparatively few and small. They include only certain coast lines and certain expanses of fresh and salt water, some deep recesses of the ocean, and a few lakes. They certainly do not include any portion of the land, and they probably do not include the open part of the large oceans. That the land and deep ocean floors may receive large deposits, the one must be depressed and the other elevated; and these processes of elevation and depression we are bound to suppose are gradual, slow, and to a certain extent reciprocal. There is thus only a very imperfect sequence, and in any one spot the gaps or intervals are likely to be much more abundant than the continuous series.

Owing to causes which we cannot here discuss, the sequence in Western Europe and the British islands admits of being conveniently grouped into three divisions; in other words, there are two principal intervals, and no more, in the long series of stratified fossiliferous rocks. In many parts of the world the gaps are much more numerous, and nowhere, as hitherto known, is the sequence more complete.

Estimating the intervals as marking lapse of time, and regarding the series of rocks as on the whole representative, these three periods are called respectively (1) PALÆOZOIC, (2) SECONDARY or MESOZOIC, and (3) TERTIARY or CAINOZOIC. Using this Greek nomenclature, all the names refer to the relative antiquity of the remains of life found in them. We may regard them as meaning the *older, intermediate* or *middle*, and *modern* groups.

The following tabular statement will give a general view of the details of arrangement under their general heads, so far as investigation has yet gone. That on the whole the series is correct may be regarded as certain, but it can in no sense be looked on as complete. It represents a large amount of truth, but much still remains to be made out by careful investigation, and a comparison of observations in every part of the globe. Care has been taken to exclude, as far as possible, theoretical views and names that involve any disputed views in geology.

TABULAR VIEW OF THE SUCCESSION OF FOSSILIFEROUS ROCKS.

RECENT DEPOSITS.

Fresh-water and Land.

- Mud, silt, and stones, in river beds and deltas, and in lakes. [ALLUVIUM.]
- Peat bog, angular and rolled gravel, and sand from glaciers. [DRIFT.]
- TRAVERTIN, from water holding bicarbonate of lime in solution.
- TUFA, and other volcanic ash.
- SILICA, from hot water in volcanic districts.
- BRECCIA, in caverns.
- Rolled material derived from occasional torrents. [DILUVIUM.]

Marine—

- Coral reefs.
- Angular and rolled material [DRIFT] derived from the destruction of shores.
- Angular and rolled gravel from icebergs. [DRIFT.]

TERTIARY OR CÆNOZOIC DEPOSITS.

NEWEST TERTIARY or UPPER QUATERNARY (*Post Pliocene*).

Fresh Water—

- Older accumulations at the mouths of large rivers. *Loess* of the Rhine.
- Older diluvium. Peat with human remains.
- Bluffs of Mississippi and almost all other large rivers.
- Older rich vegetable soils, *Tchornozeis*, *Regur*, &c.
- Cavern breccias with bones, in many parts of the world.
- Old travertins and tufas.
- Silicified trees and various deposits of silica.

Marine—

- Raised beaches and submerged forests.
- Newer boulder formation and gravel.
- Recently elevated coral reefs.
- Recently elevated volcanic islands.

PLEISTOCENE (*Middle Quaternary*) and NEWER PLIOCENE.

- Glacial drift or boulder formation of Northern Europe, Asia, and North America, with numerous remains of gigantic mammalia of extinct species.
- Cavern deposits and breccias in Europe, Asia, America, Australia, &c.
- Crag of Norwich.
- Pampas deposits of South America.
- Limestones of Girgenti in Sicily.

OLDER PLIOCENE.

- Subapennine beds.
- Crag, red and coralline, and crags of Normandy and Antwerp.
- Newer Sewalik beds of India.

MIOCENE or MIDDLE TERTIARY.

- Faluns of the Loire.
- Vienna basin and basin of the Danube.
- Older Sewalik beds of India.

EOCENE or OLDER TERTIARY.

Upper
- Hempstead and Bembridge series (Isle of Wight).
- Grès de Fontainebleau and Auvergne lacustrine beds.
- Limburg beds of Belgium.
- Mayence basin and part of German brown coal.

Middle
- Barton clay and Bracklesham sands (England).
- Calcaire grossier and grès de Beauchamp (France).
- Brussels and Laecken beds (Belgium).
- Claiborne beds, Alabama (North America).
- Nummulitic formation.

Lower
- London clay series and contemporaneous beds in France and Belgium.
- Argile plastique.

SECONDARY OR MESOZOIC DEPOSITS.

UPPER CRETACEOUS.

Upper — Chalk generally. Faxoe beds and Maestricht beds. Upper quadersandstein.

Lower — Upper greensand and gault. Hippurite limestone. Plänerkalk and lower quadersandstein.

LOWER CRETACEOUS.

Upper — Lower plänerkalk. Lower greensand series. Neacomian series (Upper).

Lower — Wealden series. Lower Neacomian.

UPPER OOLITE.

Purbeck. Portland and Kimmeridge series. Serpulite limestone of Germany. Lithographic limestone of Bavaria.

MIDDLE OOLITE.

Calc grit, coral rag, Oxford clay and Kelloway rock. Nerinæan limestone.

LOWER OOLITE.

Great oolite series. Caen limestone.

Inferior oolite series. Iron beds of Normandy and France.

LIASSIC SERIES.

TRIASSIC SERIES.

New red sandstone, and bunter sandstein with salt. Keuper, muschelkalk and bunter sandstein.

PALÆOZOIC DEPOSITS.

PERMIAN SERIES.

Magnesian limestone, lower new red sandstone, and dolomitic conglomerate. Roth liegender, kupfer schiefer, and Vosges sandstone.

CARBONIFEROUS SYSTEM.

Upper Series—

Coal measures with shales and grits and much coal. Millstone grit overlying coarse and fine shales.

Lower Series—

Carboniferous limestone and kiesel-schiefer. Deposits and veins of lead and zinc ore. Lower limestone and shales with poor coal. Culmiferous series and calp. Pentremite limestone, U.S.

DEVONIAN SYSTEM.

Herefordshire conglomerates and Scottish sandstones of the old red sandstone. Russian Devonian series, Catskill group, U.S. Eifel limestone, Spirifer sandstone, and old Rhenish greywacke. Devonshire series of shales and limestones. Corn-stones of Herefordshire. Arbroath paving-stones and Caithness schists.

SILURIAN SYSTEM.

Tilestone. Ludlow and Aymestry rocks. Wenlock series and Upper Caradoc series. New York series, upper part. Bohemian series. Russian and Scandinavian, and North American limestones.

CAMBRIAN SYSTEM.

1. Lower Caradoc and Llandeilo flags. Bala limestone. Scotch graptolite schists and Kildare limestone (Ireland). Lower part of New York and Bohemian series. Angers slates.

2. Arenig and Tremadoc beds and Lingula flags. Harlech grits, Llanberis slates, and lowest Wicklow fossiliferous rocks. Bohemian primordial zone. Swedish alum schists. Potsdam sandstone. Wisconsin series.

LAURENTIAN SYSTEM.

Gneiss and mica schist with crystalline limestone, occupying a large area north of the St. Lawrence in North America. Fossils have been found in serpentines of this series.

Some details of each principal group of rocks named in the above table will be found under its own heading, and the characteristic groups of fossils will also be explained so far as a knowledge of them is necessary. Employing the various references, the reader may obtain an idea of the extent of the department of geology thus outlined.

Beneath and amongst the stratified rocks are various others that are crystalline, altered, and unstratified, and to all appearance the result of causes now most nearly exemplified in the case of volcanic products. Those underlying the whole series, or whatever part of the series carries us down below fossiliferous rocks, are usually porphyritic, and of the nature of granite. Those filling up crevices, whether formed by contraction or elevation [MINERAL VEINS], are frequently crystalline and metalliferous; and igneous rocks, now lying on the surface or interposed between fossiliferous rocks, clearly mechanical in their origin, are *basaltic*, *trachytic*, or *greenstone*.

All these igneous rocks agree in the absence of any marks of mechanical origin. The three latter have been apparently thrust up through overlying strata in a melted state. The first-named have been formed at great depth in the earth, subjected to influences only existing there, and little known to us. They were probably elaborated from old rocks, but are now altogether crystalline. Lastly, the minerals filling crevices have been separated and deposited atom by atom either with water or steam, independently of mechanical agency; but not without reference to the nature of the enclosing rock.

It will be seen from this brief account how independent of the stratified rocks, in respect to age, all these crystalline rocks are.

The arrangement, then, of the igneous, chemical, or unstratified rocks must be essentially distinct, and governed by different principles from those enunciated in reference to the stratified series. When underlying, they are not necessarily older; and when they are interstratified, or occupying veins, their age is marked only in reference to the rocks they cover or penetrate. The granite of Cornwall below Silurian rocks, which are little altered by its proximity, is doubtless very old; but the granite of the Alps, similar if not identical in all important characteristics, is probably newer than some of the middle secondary rocks. Such granite may be in course of formation at this moment, being made out of tertiary rocks; but when cooled may well agree in all essentials with the oldest. So, again, mineral veins in the granite and slate of Cornwall contain the same minerals arranged in the same way as is the case with veins in similar rocks of the tertiary period occurring in the copper-mining

district of Algeria. So also basalt was poured out over the chalk on the north coast of Ireland before the commencement of the deposit of tertiary rocks; but it is exactly similar to the lava of Iceland or Etna erupted during this century.

A third group of rocks exists—those which were certainly once of mechanical origin, and were deposited after long suspension in water, but which now are so completely altered as to have lost almost all mark of their origin. Gneiss, micaceous and clay slates, quartzites, and some marbles are all of this kind: they are *metamorphic rocks* in the strict sense of the word, and have undergone a great change. They must be arranged according to some method that does not require an examination or comparison of fossils; for with them to be fossiliferous is an exceptional condition. Their mineral condition, also, though by no means always the same, is strictly dependent on causes which seem to have no reference to the date of their origin.

Ultimately, no doubt, all rocks must be judged of by a consideration of the determinable deposits containing fossils with which they are most nearly associated.

3. *Detailed Account of Formations.*—This part of the subject is given under the various principal headings referred to in the list of formations. It is unnecessary here to repeat the details.

Descriptive geology with palæontology—the two forming together one great department of geology—is thus seen to involve a serious and lengthened statement of facts and necessary inferences. When properly studied, it leads on the one hand to very important practical conclusions, and on the other to philosophical considerations and theoretical views hardly less important. The former will be noticed under the head of Economic Geology, and the latter will some day form a department which may with propriety be called Physical Geology; but at present, and in this work, theoretical considerations are best excluded. [Geology; Physical Geology; Aqueous Rocks.]

Descriptive Geometry. The object of Descriptive Geometry, in the sense first used by Monge, is to obtain such a representation, *in plano*, of an accurately defined body in space as will serve for the investigation of the *metrical* as well as of the descriptive properties of that body. It differs from ordinary perspective inasmuch as by the latter method the actual dimensions of a body cannot be ascertained from its representation.

In descriptive geometry, points in space are represented by their orthographical projections on two planes, at right angles to each other, called the *planes of projection*. It is usual to suppose one of the planes of projection to be horizontal, in which case the other is vertical; and the projections are called *horizontal* or *vertical*, according as they are on the one or the other of these planes. Accordingly, any curve in space will be represented by two curves in the horizontal and vertical planes, and a curved surface by the corresponding representations of certain points and curves on that surface. Thus a plane would be completely defined by its intersections with the planes of projection. The intersections of a line or surface with the planes of projection are called its *traces*. Again, a sphere may be conveniently represented by the projections of its horizontal (or vertical) great circle; a cylindrical surface by its trace on one of the planes of projection, and the projection of any generator on the other; a cone by the projections of its vertex and by one of its traces, &c.

Although applicable to sculpture, architecture, painting, and all mechanical arts, it was chiefly in consequence of its application to civil and military engineering, and to fortification, that this branch of geometry received a distinctive appellation. It was considered of sufficient importance to form one of the principal departments of study in the Polytechnic school of France. The best systematic works written on the subject are those of Monge, Hachette, Vallée, Olivier, Amiot, Leroy, Lacroix (*Essais de Géométrie &c.* Paris 1840), Hall and M. de la Gournerie.

Desert (Lat. deserta, *forsaken places*). A term generally used to designate an uninhabited place or solitude. In this sense, it is equally applicable to the fertile plains watered by the Marañon, and the wastes of Libya; but it is applied more particularly to the vast sandy and stony plains of Africa and Asia. In every region of the globe plains are to be found of greater or less extent, which, though marked by strong features of resemblance in their grand outlines, exhibit with the different latitudes in which they are placed a corresponding variety of character, and according to the distinguishing peculiarities of each are known by different appellations. Thus we have the Steppes of Europe, the Deserts of Asia and Africa, the Savannahs of the Mississippi and the Missouri, and the Pampas and Llanos of South America. [See these different articles.]

The most striking feature of North Africa consists of its immense deserts, which have in all ages presented to the speculations of the geographer objects highly worthy of attention. Of these the chief is the Sahara, or *the Desert*, so called by way of eminence. In many parts the dreary waste of loose and hardened sand is broken by low hills of naked sandstone, or by tracts of arid clay, and occasionally it is enlivened by verdant isles or Oases, which serve as resting places for the caravans that traverse these dismal regions. But for these *oases*, indeed, the Sahara would be wholly impassable. It presents, says Malte Brun, no traces of a beaten path; and the caravans that traverse it, directing their way by the polar star, describe a tortuous road in order to profit by the oases, which are represented as brilliant with vegetation, but which probably owe a great part of their reputation to the contrast they form with the absolute barrenness of the desert.

The great deserts of Africa are separated from those of Asia only by the valley of the river Nile and the Red Sea. Soon after quitting the Nile, the traveller by the route of Suez encounters sand, which is continued into the centre of Arabia, where it forms the desert of Nedsjed, extending to the valley of the Euphrates. The sandy zone then inclines northward, enters Persia, and forms the saline deserts of Adjemi, Kerman, and Mekran; it is turned north-east by the valley of the Indus, passes through Cabul and Little Bukharia, till it joins the vast deserts of Cobi and Shamoo, which occupy so large a portion of Central Asia between the Altaian and Mustag chains, and reach to the confines of China. The sandy zone, thus traced throughout the breadth of the ancient continent from Western Africa to 120° of east longitude, has been computed to cover an area of 6,500,000 square miles; but the Asiatic portion of this tract includes many chains of mountains and fertile valleys. It is characterised by the occurrence of arid wastes of sand or clay, sometimes with saline incrustations on the surface, and is remarkably deficient in considerable rivers. Except the Nile, the Euphrates, the Indus, and the Oxus, there are no large rivers in a region which embraces almost a fourth part of both Africa and Asia. This portion of Central Asia forms a series of elevated plains 6,000 miles in length from east to west. Some of these plains, says Humboldt, are covered with herbage; others produce only evergreen saliferous plants, with fleshy and jointed stems; but a great number glitter from afar with a saline efflorescence that crystallises in the semblance of lichens, and covers the clayey soil with scattered patches like new-fallen snow.' (Dr. Traill's *Physical Geography*. pp. 21, 22.) Under the head MIRAGE will be found some account of a singular optical illusion often seen in the desert.

In the Old Testament the term *desert* bears a wholly different interpretation from that usually attached to it in other writings. It has been fully shown by Reland (*Palest.* l. i. p. 375) that the Hebrew מדבר (midbar), the ἐρῆμος of the Greeks, and the *desertum* or *solitudo* of the Latins bear no analogy to each other; the first being appropriated almost exclusively to those thinly peopled districts of the Holy Land which yielded pasturage for cattle, and were remarkable at once for their beauty and the luxuriance of their vegetation.

Deserter (Lat. desertor, from desero, *I forsake*). An officer, soldier or sailor, who absents himself from his duty without permission, and with the intention not to return. The crime of desertion has in all ages and countries been regarded with peculiar detestation. In Greece and Rome, the deserter, during war, suffered death; during peace, was deprived only of civil rights: a sound and enlightened distinction. The military code of Great Britain inflicts 'death or such other punishments as may be adjudged by a court-martial' on deserters; thus leaving a proper discretionary power for the exercise of lenity in cases where the motives to the crime may bear the most favourable construction. Any soldier absent without leave for more than twenty-one days, must be tried by court-martial for desertion.

Desiccatives (Lat. desicco, *I dry up*). In Materia Medica, applications which dry up the secretion of membranes, ulcers, &c.

Design (Fr. dessin, from Lat. designo, *I mark out*). In all the Arts, the idea formed in the mind of an artist on any particular subject, which he endeavours to transfer to some medium for the purpose of making it known to others. It is sometimes loosely and improperly used as synonymous with *drawing*.

Every work of design is to be considered either in relation to the art that produced it, to the nature of its adaptation to the end sought, or to the nature of the end it is destined to serve; thus its beauty is dependent on the wisdom or excellence displayed in the design, on the fitness or propriety of the adaptation, and upon the utility of the end. The considerations of design, fitness, and utility, have become the three great sources of beauty of form. This beauty frequently arises from the combined power of these expressions.

Every work of art supposes unity of design, or some particular end proposed by the artist in its structure or composition. In every beautiful work of art, we are not satisfied with mere utility—we must have elegant design, of which the grand feature is variety; it is this which in general distinguishes beautiful from plain forms, and without it uniformity is dull and insipid. [DECORATION.]

Designator (Lat.). In Roman Antiquities, the title of an officer who arranged and marshalled the funerals of distinguished persons. He was attended by a troop of inferior officers, all arrayed in black, whose part it was to keep off the crowd, like the lictors of the magistrates. (Horace, *Ep.* i. 7.)

Desmidiaceæ (Desmidium, one of the genera). A group of cryptogams, referred to the *Algæ*. The plants are made up of a chain of connected joints, increasing by the continued addition of two new half-joints in the centre, so that the two extreme members of the chain are the oldest, and the two in the centre the youngest. Usually disarticulation takes place on the formation of the first new half-joints, in such a manner that the two new individuals consist of half the old plant connected with half of the new. Fructification (adds Mr. Berkeley, from whose account we quote) takes place, though rarely, by the conjugation of two individuals by means of lateral tubes or simple contact, the spore affecting a variety of interesting forms. The new individual is produced from this by the formation of a vertical partition in the centre, and the subsequent formation of two new half-joints, so that the proper form of the species is not attained till the third generation, if so soon. The *Desmidiaceæ*, which occur in pools, running streams, &c., differ from the *Diatomaceæ* by their green colour and

the absence of silex. (See Ralfs' *British Desmidieæ*, for a minute account of these curious plants.)

The animal nature of these organisms has been supported by Mr. Dalrymple on the ground of their developing a true vitelline nucleus, transparent but molecular fluid, and a chorion or shell in their ova.

Desmine (Gr. δέσμη, *a bundle*). A variety of foliated *Zeolite*.

Desmology (Gr. δεσμός, *a bond*, and λόγος, *description*). That part of Anatomy which relates to tendons and ligaments.

Despot (Gr. δεσπότης, *master*). A name applied to sovereign princes possessing absolute authority. Under the Byzantine emperors, *despot* was one of five titles conferred on princes of the royal blood. (Gibbon's *Roman Empire*, ch. liii.)

Despotism. In Politics, absolute and irresponsible government by a single individual. [LIBERTY.]

Despumation (Lat. despumatio, from spuma, *froth*). The clarification of a liquor by skimming off the froth thrown up by boiling or fermentation.

Desquamation (Lat. squama, *scale*). The separation of layers or scales from the skin or bones.

Dessert. A word of doubtful etymology, signifying the last service at dinner, consisting of fruits, confections, &c. The modern dessert is probably equivalent to the *mensæ secundæ* of the Romans. If we believe Congreve, the term came into use among the French about the commencement of the seventeenth century, and was soon adopted into and naturalised in most of the European languages.

Destemper. [DISTEMPER.]

Destiny (Lat. destinare, *to appoint*). An inevitable necessity depending upon a superior cause. This doctrine has, under a variety of names, been embodied in almost all the religious systems of antiquity; and even in modern times, with a few modifications, it has been largely adopted by many sects of the Christian church. [PREDESTINATION; NECESSITY.] Destiny was called by the Romans *Fatum* [FATES], and by the Greeks Ἀνάγκη, *Necessity*. The Stoics understood by destiny a certain concatenation of things, which from all eternity follow each other of absolute necessity, there being no power able to interrupt their connection. To this invisible power even the gods were compelled to succumb. (Euripides, *Alc.* 965; Herodotus i. 91.)

Destructive Distillation. A term applied to the distillation of organic products at high temperatures, by which the ultimate elements are separated or evolved in new combinations. The destructive distillation of coal is resorted to for the production of gas, that of bone for the production of ammonia, and that of wood for the formation of vinegar.

Desvauxiaceæ (Desvauxia, a synonym of one of the genera). A small group of monocotyledonous plants of New Holland and the South Sea Islands, having bristly leaves and glumaceous flowers. They have no particular interest.

Detached (Fr. détaché). In Painting, a term applied to all objects in a picture which appear to stand out or be relieved from those by which they are surrounded. It arises from a due knowledge of aërial and linear perspective.

Detached Works. In Fortification, works constructed beyond the range of the musketry of the main work.

Detachment (Fr. détachement). In Military language, a party of troops detached from the main body, and placed under a temporary separate command, for any special duty.

Details (Fr. détail). In the Fine Arts, the parts of a work as distinguished from the whole as a mass. They must always be so kept under as not to interfere with the general effect of the work; neither must they be overlaboured, lest, instead of aiding, they embarrass the work of which they form parts. [DECORATION.]

Detents. In Clockwork, the stops which lock and unlock the machinery in striking.

Detergents (Lat. detergeo, *I wipe away*). Medicines which remove viscidity, and cleanse sores.

Determinant, Functional. Any determinant whose constituents are functions of sets of variables. [HESSIAN; JACOBIAN.]

Determinants. A preliminary reference to the words MATRIX and RULE OF SIGNS will render the following definition of these important algebraical expressions at once intelligible. *A determinant is the algebraical sum of the products of the principal constituents of the matrices obtained from a given square matrix, by permuting its columns (or lines) in all possible ways, the sign of each product being that which is due, according to the rule of signs, to the arrangement of columns (or lines) in the corresponding matrix.* A convenient though somewhat cumbrous symbol for a determinant is obtained by writing its matrix between two vertical lines. The *order*, *principal diagonal*, *constituents*, *principal constituents*, *conjugate constituents*, &c. of a determinant coincide, respectively, with those of its matrix. Thus a determinant of the third order is symbolised by

$$\begin{vmatrix} a_1, & b_1, & c_1 \\ a_2, & b_2, & c_2 \\ a_3, & b_3, & c_3 \end{vmatrix},$$

and its developed value, according to the above definition, is

$$a_1b_2c_3 - a_1b_3c_2 + a_2b_3c_1 - a_2b_1c_3 + a_3b_1c_2 - a_3b_2c_1,$$

such as

$$\begin{vmatrix} a, & d, & e \\ d, & b, & f \\ e, & f, & c \end{vmatrix}.$$

A determinant whose conjugate constituents are equal is said to be *symmetrical*; if these conjugate constituents, however, are opposite in sign and merely equal in magnitude, the determinant is said to be *skew*; and lastly, a skew-determinant whose principal constituents are

zeros is said to be ***skew-symmetrical.*** [SKEW-SYMMETRICAL.]

The determinant whose matrix is obtained from that of a given determinant of the n^{th} order by omitting any m columns and any m rows is called an m^{th} ***minor***, and the latter is said to have for its ***complement*** the $(n-m)^{\text{th}}$ *minor* formed by omitting the lines and columns that were before retained. A minor is called a *principal minor*, if its principal constituents were also principal constituents of the original determinant.

The properties of determinants are very numerous; we can here only state a few of the most elementary and important ones, referring the reader, desirous of further information, to one of the many valuable treatises on the subject which now exist, and amongst which those of Spottiswoode, *Elementary Theorems relating to Determinants*, London 1851; Brioschi, *Teorica dei Determinanti*, Pavia 1854 (translated into French and German by Combescure and Schellbach, respectively); Balzer, *Theorie und Anwendung der Determinanten*, Leipzig 1857; and Trudi, *Teoria di Determinanti*, Napoli 1862, deserve especial mention.

A determinant is not altered in value when its lines are written as columns and its columns as lines, the same order being preserved. If two columns, or two lines, are interchanged, the determinant changes its sign but not its absolute value, so that a determinant, two of whose columns or lines are alike, vanishes identically. The multiplication of the constituents of a column or line by any factor is equivalent to the multiplication of the whole determinant by that factor; for the determinant is obviously a linear function of the constituents in any column or line. From this it follows, too, that a determinant having, for constituents in any line or column, sums of the same number of terms is equal to the sum of an equal number of simpler determinants; thus

$$\begin{vmatrix} a_1+\alpha_1, & b_1, & c_1 \\ a_2+\alpha_2, & b_2, & c_2 \\ a_3+\alpha_3, & b_3, & c_3 \end{vmatrix} = \begin{vmatrix} a_1, & b_1, & c_1 \\ a_2, & b_2, & c_2 \\ a_3, & b_3, & c_3 \end{vmatrix} + \begin{vmatrix} \alpha_1, & b_1, & c_1 \\ \alpha_2, & b_2, & c_2 \\ \alpha_3, & b_3, & c_3 \end{vmatrix}.$$

The general rule for the multiplication of determinants of like order will be readily detected in the following simplest instance:—

$$\begin{vmatrix} a_1, & b_1 \\ a_2, & b_2 \end{vmatrix} \begin{vmatrix} \alpha_1, & \beta_1 \\ \alpha_2, & \beta_2 \end{vmatrix} = \begin{vmatrix} a_1\alpha_1+b_1\beta_1, & a_1\alpha_2+b_1\beta_2 \\ a_2\alpha_1+b_2\beta_1, & a_2\alpha_2+b_2\beta_2 \end{vmatrix},$$

and it will suffice to add that determinants of unlike orders can be multiplied by the same rule, since, without alteration of value, the order of a determinant can be easily raised.

A determinant may always be exhibited as an algebraical sum of products of minor determinants. Thus,

$$\begin{vmatrix} a_{11}, & a_{12}, & a_{13}, & a_{14} \\ a_{21}, & a_{22}, & a_{23}, & a_{24} \\ a_{31}, & a_{32}, & a_{33}, & a_{34} \\ a_{41}, & a_{42}, & a_{43}, & a_{44} \end{vmatrix}$$

$$= \Sigma \pm \begin{vmatrix} a_{11}, & a_{12} \\ a_{21}, & a_{22} \end{vmatrix} \begin{vmatrix} a_{43}, & a_{34} \\ a_{43}, & a_{44} \end{vmatrix},$$

where the summation sign refers to all possible products of complementary minors one factor of which is formed by omitting the first two, and the other by omitting the last two lines; the sign of each product being that which corresponds, according to the rule of signs, to the product of the principal constituents of the factors.

In the above illustration, the notation of double suffixes has been intentionally employed for the several constituents; on account of its symmetry this notation has many advantages. In connection therewith it may be remarked that the bearer a of the various suffixes may also be omitted, and the constituent in the third row and second column may be equally well represented by the symbol (32). This last method of representing quantities is in accordance with the *umbral notation* invented by Sylvester, who denotes a determinant by the more compact symbol,

$$\begin{Bmatrix} 1, 2, 3 \dots n \\ 1, 2, 3 \dots n \end{Bmatrix},$$

where the symbols in the lower line are to be permuted in all possible ways. If $\alpha_1, \alpha_2 \dots \alpha_n$ represent any such permutation, the product $(1, \alpha_1)$ $(2, \alpha_2) \dots (n, \alpha_n)$ taken with its proper sign will obviously be a term of the determinant.

By the *determinant of the reciprocal system* is meant one whose constituents are, respectively, the first minors which, in a given determinant of the same order, appear as coefficients of the corresponding constituents. Such a determinant is always equal to the $(n-1)^{\text{th}}$ power of the given determinant, and any m^{th} minor of it is equal to the $(m-1)^{\text{th}}$ power of the original determinant multiplied by the complement of the corresponding m^{th} minor of the original system.

With respect to the history of determinants, any one of the before-mentioned treatises, and especially that of Balzer, may be consulted. We cannot conclude this short notice, however, without reference to Jacobi's two important memoirs, entitled *De Formatione et Proprietatibus Determinantium* and *De Determinantibus Functionalibus*, the appearance of which in Crelle's *Journal* marked an epoch in the progress of mathematics. According to the notation employed by this author, a determinant is represented by the symbol

$$\Sigma \pm (a_1' a_2'' a_3''' \dots a_n^{(n)}),$$

the summation sign being supposed to extend to all possible permutations of the affixes or suffixes, and the sign of each term being determined as before.

Determinate Problem. In Geometry, a problem which admits of a *limited* number of solutions; an *indeterminate problem* being one which admits of an indefinite number of solutions. Thus the problem, *Given the base, perimeter, and area, to construct the triangle*, is determinate, there being, in general, but four solutions. By omitting one of the three data, however, the problem becomes indeterminate. For instance, an infinite number of triangles

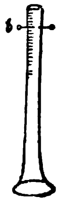
having the same perimeter can be constructed on a given base. Nevertheless the problem is not *perfectly* indeterminate, for the vertices of all such triangles are restricted to a certain locus, viz. the ellipse whose foci are the extremities of the given base. In general, the omission of one of the conditions or data which render a problem determinate leads to a *local problem.*

Determinatives (Lat. determino, *I mark off*). Ideographic signs annexed to a word expressed by phonetic signs, for the purpose of defining its signification. Thus a figure of a tree is in the Egyptian hieroglyphics determinative of the name of trees; but the figure so employed does not express the word of which it is the symbol. In the words of Baron Bunsen, 'it only determines the meaning of the preceding phonetic sign, the sense of which would otherwise remain doubtful to the reader, owing to the various significations of the same Egyptian roots.' (*Egypt's Place in Universal History* i. 263–5.) [ALPHABET.]

Detinue. In Law, a personal action of contract, which lies where a party seeks to recover goods and chattels, or deeds and writings, detained from him. [PLEADING.]

Detonating Powder. A term applied in Chemistry to fulminating mercury and silver, and to other compounds which suddenly explode when struck or heated. Some of these compounds have lately been much used for the ignition of gunpowder in percussion locks, and in the fuzes of shells for rifled guns.

Detonating Tube (Lat. detono, *to thunder*). A stout glass tube used in the chemical laboratory for the detonation of gaseous bodies. It is generally, as represented in the annexed cut, graduated into centesimal parts, and perforated by two opposed wires for the purpose of passing an electric spark through the gases which are introduced into it, and which are confined within it over water or mercury. When a detonating tube is used over either of these fluids, the smallest possible quantity of explosive gas should be introduced into it, as, in consequence of the expansion which ensues, a portion is apt to be forced out at the moment of the explosion. The tube, when used, should be firmly held; a spring is sometimes substituted for the grasp of the hand, but it is inconvenient.



Detonation. When chemical combination or decomposition is sudden and attended by flame and explosion, it is often said to be effected by *detonation*. If a mixture of hydrogen and oxygen be inflamed by the electric spark or by a taper, it burns rapidly and with explosion, and is said to *detonate*. When a grain or two of phosphorus is mixed with chlorate of potassa and struck with a hammer, the mixture detonates.

Detritus (Lat. part. of detero, *I rub off*). A term used in Practical Geology to express the minute portions of a rock, or a deposit, which may have been detached and removed to a distance by the action of any abrading power.

Detrusion (Lat. detrudo, *I thrust aside*). The action of any force to thrust outwards a body exposed to its influence; as in the case of an embankment behind a retaining wall; or of an arch, or a truss, acting upon a pier, or other point of support intended to receive its effect. The word *detrusion* is in fact nearly synonymous with the expression *outward thrust*; and in most cases it may be conveniently substituted for it.

Deucalion. In Greek Mythology, the son, according to the Hesiodic Catalogue, of Prometheus and Pandora, and the husband of Pyrrha, who with him alone escaped the great deluge which overwhelmed the land in the reign of Ogyges. (Grote's *History of Greece*, part i. ch. v.)

Deus ex Machinâ (Lat.). A scholastic expression, borrowed from the stage. By a certain machine, the gods were represented as flying in the air. When any such intervention, contrary to the maxim of Horace,

> Nec deus intersit nisi dignus vindice nodus,

took place without an adequate cause, it was condemned as injurious to scenic effect. Hence the proverb, which has also been applied by analogy to those philosophers who, unable to solve a difficulty by ordinary means, have immediate recourse to the aid of a supernatural power.

Deuteronomy (Gr. δευτερονόμιον, *the second law*). The name given to the last book of the Pentateuch. It is equivalent to the *Mishna* of the Hebrews, who thus designated the book of Deuteronomy, from its containing a recapitulation of the laws and ordinances scattered in the other books of Moses. [PENTATEUCH.]

Deuteropathia (Gr. δεύτερος, *second*, and πάθος, *disease*). A sympathetic affection of any part; as a headache from an overloaded stomach, or sickness from an injury of the head.

Deutoxide. A term applied in Chemistry to certain compounds containing *one* atom or equivalent of base in combination with *two* of oxygen; in this sense the word is synonymous with *binoxide*. It is sometimes indiscriminately applied to the second degree of oxidisement of which bases are susceptible.

Developable Helicoid. [HELICOID.]

Developable Osculatrix. The developable surface generated by the tangents of a non-plane curve. Every tangent plane of the surface is an osculating plane of the curve. [CURVE.]

Developable, Polar. [POLAR DEVELOPABLE.]

Developable Surface. A ruled surface the consecutive generators of which intersect each other. [RULED SURFACE.] The non-plane curve generated by the successive intersections of these generators is called the *cuspidal edge* or *edge of regression* of the surface—since every plane section of the developable has a cusp at the point where its plane meets this curve

The plane of two successive generators is clearly a tangent plane of the surface, and an osculating plane of its cuspidal edge. It touches the surface at every point of the generator: if we conceive it to be turned around this generator as a hinge until it coincides with the next tangent plane, and these coincident planes to be turned similarly around the next generator, it is obvious that the whole surface may, without crumpling or tearing, be unfolded into a plane; hence the term *developable*. Such a surface may also be regarded as the envelope of a plane which satisfies any two conditions, and whose equation $u=0$ therefore contains one variable parameter a. The equation of the developable envelope of the plane $u=0$ is obtained by eliminating a from the equations $u=0$ and $\frac{du}{da}=0$; the equations of its cuspidal edge result in like manner from the elimination of a from $u=0$, $\frac{du}{da}=0, \frac{d^2u}{da^2}=0$. Lastly, the elimination of x, y, z from the last three equations and $\frac{d^3u}{da^3}=0$ gives an equation in a whose roots correspond to tangent planes which are met by three consecutive ones in the same point; the latter will be a stationary point on the cuspidal edge. [ENVELOPE.] In like manner a developable may have one or more stationary tangent planes, that is to say tangent planes each of which coincides with the consecutive one. The number of generators which meet a given line determines the *order* of the developable, which is obviously the same as the *class* of its cuspidal edge. [CURVE.] Further, the number of tangent planes which pass through a given point defines the *class* of the developable; thus, the degree in which a enters into the equation of the plane $u=0$ is the class of the developable it envelopes. Every generator of a developable will, in general, be intersected by a number of other non-consecutive generators in points which form a *nodal* or *double curve* of the surface. The order of this curve and the other singularities of the surface may be ascertained, as Cayley has shown (*Cambridge and Dublin Mathematical Journal*, vol. v.), by aid of Plücker's equations connecting the singularities of plane curves. The Hessian of a developable is reduced to zero by the coordinates of every point of the surface, and must consequently contain the equation of that surface as a factor. The remaining factor, of the $(3n-8)^{th}$ degree, is called the *Pro-Hessian*. The Hessian equated to zero is equivalent to the partial differential equation

$$\frac{d^2z}{dx^2}\cdot\frac{d^2z}{dy^2}-\left(\frac{d^2z}{dx\,dy}\right)^2=0,$$

which is satisfied by every developable.

Developement (Fr. développement, *an unfolding*). The stages which an animal passes through before arriving at the epoch of fecundation or *Gamomorphic* period, are termed stages of developement. The law was first enunciated by John Hunter, that each of the higher animals during its embryo phases passes through stages which are persistent in the lower animals of the same subkingdom to which it belongs. Thus, the human embryo adopts at its earliest period the aspect of a ciliated monad or infusory; and from that stage passes through phases analogous to, though not absolutely identical with, those of the lower vertebrata. This law, as well as that of Parthenogenesis, has been urged as demonstrating the existence of a constantly operating secondary law, which has produced the various diversified and specialised animal forms. The more generalised structure of many of the extinct animals, e.g. *Archegosaurus*, *Anoplotherium*, as compared with the fauna of the present day, in which functions once performed by one individual or set of organs are now distributed amongst several genera and more diversified structures, are examples of the law that the special forms have now superseded the more generalised or embryonic forms in the developemental scale.

DEVELOPEMENT. In Theology, a phrase which has of late years obtained some currency, chiefly in England, through the famous *Essay* of Dr. J. H. Newman, written to explain his view of the general bearing of Roman Catholic doctrine at the time when he went over to that church. According to its theory, a dogma, not in express terms promulgated nor distinctly known to the early church, may become established by the church and received as matter of faith in later times, provided only, when thus expanded, it is in real accordance with the less complete views attained at an earlier period by the same continuing authority. As, for instance, the dogma of the supremacy of the see of Rome is one of which the full 'developement' was reserved for later times, although all that remains to us on the subject, from the tradition of earlier times, is, according to this theory, in consistency with it.

Deviation of the Compass. The variation of a ship's compass from the true magnetic meridian is caused by the near presence of iron; and in iron ships depends upon the direction, with regard to the magnetic meridian, in which the ship was built. This subpolar magnetism of the ship, caused by the hammering of the plates, runs down, as it were, very rapidly, and necessitates frequent corrections. It is least when the ship has been built, as to magnetic meridian, head south. Armour-plated ships should be plated with the head in the opposite direction to that of building.

There are two methods in practice by which this variation is attempted to be neutralised: the first is by ascertaining the actual variation in every position of the ship with regard to the magnetic meridian and working by a table of errors; the other is by introducing on board ship masses of iron and magnets to exactly neutralise the action of the ship's magnetism. The latter method, which corrects the compass, is now very generally employed, and has many

advantages. To accomplish it, the ship's head is placed magnetic north or south by the aid of a shore compass viewing her masts; a magnet is placed on the ship's deck in an athwart position ahead or astern of the compass, and is slid nearer or farther till it causes the compass to point correctly. The ship is then placed magnetic east or west, and another magnet is placed in a fore and aft position on the deck on one side of the compass, and is slid nearer or farther till it causes the compass to point correctly. The magnets do not interfere with each other's action. The ship is lastly placed in an intermediate position, and a mass of iron is placed on one side of the compass to correct quadrantal deviation. It is of very great importance that the ship should not be hurried out immediately for a long voyage, but that she should be exposed to tremors for some days, and that her compasses should be readjusted before sailing on a long voyage.

For further information, see *Admiralty Manual*, and *Proc. Roy. Soc.* April 1865.

Devil (Ger. teufel, Fr. diable, generally connected with Gr. **διάβολος**, ***an accuser***). The word bears the same sense as Satan, and is applied in the New Testament to the evil principle, the adversary of man referred to throughout the Old and New Testaments, under various names and titles, as Satan, Lucifer, Belial, Apollyon, Abaddon, the Man of Sin, the Tempter; and described as an angel who fell from heaven with many inferior spirits, being cast down thence by God for his pride and rebellious spirit. From that time he is said to have had permission to try and tempt mankind. He is represented in Job and Zechariah as standing in the presence of the Lord, seeking permission to tempt men. The character herein attributed to the Devil is identical with that of the Evil Principle in the Gnostic and Manichean philosophy; excepting, indeed, that the Scriptures always maintain the inferiority of the evil to the good. [Demon.]

Devil. In Printing, formerly the boy who took off the sheets as printed from the tympan of the press; they, as old Moxon says, 'do in a printing house commonly black and bedaub themselves: whence the workmen do jocosely call them *devils*.' The term is now applied to the *messengers*.

Devil's Dung. An old pharmaceutical name of *assafœtida*.

Devilline. The name given by M. F. Pisani to a newly discovered mineral, in honour of M. H. Sainte-Claire Deville. It is a hydrated subsulphate of copper with about 8 or 10 per cent. of lime, which, doubtless, partly replaces the copper. It is found in Cornwall, in the form of very pale bluish-green tender crusts, composed of exceedingly small crystalline laminæ: the crusts having externally an earthy appearance, but a silky lustre on fractured surfaces.

Devise or **Device** (Fr. deviser, *to invent, will*, or *imagine*). In Heraldry, the term *devise* is popularly used in the same sense as Armorial Bearings [which see]; but it is more strictly employed to signify a symbol, consisting of a representation of some visible object, and in many instances a motto appropriate to it, used, not by way of heraldic bearing, but according to the fancy of the inventor: sometimes [illegible] the motto alone.

Devise (Fr. deviser, in its old meaning, [illegible] *will*). In Law, is a gift of lands by a [illegible] will and testament. Lands held in fee-simple became devisable, where not so by special custom, by the statute 34 & 35 Hen. VIII. c. 5. By 3 & 4 Wm. & Mary, c. 14, devises were made void against specialty creditors. Estates pur auter vie are devisable by stat. 29 Ca. II. c. 3. A will of lands formerly only operated on those lands of which the testator was possessed at the time of publishing it. [Will.] But by the present Statute of Wills (1 Vict. [illegible] 26) every will is held to speak, both as to real and personal property, as if executed immediately before the death of the testator.

Devitrification (Lat. vitrum, *glass*). A peculiar change which takes place in glass, in consequence of the action of certain decomposing agents. Thus glass long exposed to ammoniacal fumes, or which has been long acted upon by water, is subject to this change. It is characterised by the surface becoming dull and earthy; its losing transparency, and assuming a kind of opaline iridescence; it also becomes more fibrous, and less brittle, than ordinary glass. Some glass vessels discovered in Greek, Roman, Egyptian, and Assyrian tombs [illegible] marks of this kind of decay.

Devonian System. One of the [illegible] names now frequently adopted to designate a particular phase of the middle member [illegible] great Palæozoic series of rocks as developed [illegible] the northern hemisphere, and chiefly in the western part of it.

Although recognised as belonging to an early period of the earth's history, the [illegible] grits, impure limestones and flags, and [illegible] calcareous slates and limestones of various parts of Devonshire, were long misunderstood, and the so-called 'old red sandstone' of Herefordshire and Scotland was for some time [illegible] scribed by English geologists as the only [illegible] of rocks separating the carboniferous from [illegible] recently described Silurian series. Im[illegible] groups of slates and limestones, not [illegible] ferous, were known to exist in the Eifel, near the banks of the Rhine; but these [illegible] not, at the time we speak of, identified [illegible] deposits already occupying a recognised position in the geological series.

Under these circumstances the proof [illegible] tained by Sir R. Murchison and Professor Sedgwick, that these Devonian rocks were [illegible] temporaneous both with the old red sandstone and with the Eifel series, was a great [illegible] advance, and tended to fix very im[illegible] positions in geological classification. The [illegible] sequent discovery of the conglomerates of [illegible] old red sandstone, and the fossiliferous [illegible] of Devonshire and the Rhine, side by side

alternating with each other in Russia, was one of the many valuable observations which geology owes to Sir R. Murchison.

The Devonian beds, strictly so called, are generally fossiliferous, and sometimes richly so; but the condition of the fossils in England is usually very bad. The lower portion of the series consists of the Plymouth and other limestones in the south, loaded with corals, and represented by coarse grits in the north of Devon and the Cornish slates. Overlying these are red flags and slates. Sometimes other limestones at the top intervene between these and the culmiferous bed of the carboniferous system. [CARBONIFEROUS SYSTEM.]

Normandy presents Devonian rocks in a characteristic state, and they are traceable at intervals along the north of France into Belgium, where they form part of the great Rhine and Nassau series. The Russian Devonians occupy a tract nearly as large as Great Britain, lying on Silurian rocks rising nearly 1,000 feet above the sea, and apparently unaltered. In various parts of North America, and even in South America and Australia, Devonian formations recur.

Metalliferous veins are abundant in the Devonian slates and schists of Devon and Cornwall, and near the contact of these with granite. Copper is the principal metal; but argentiferous galena and blende are common in certain parts of the district. [OLD RED SANDSTONE and PALÆOZOIC.]

Devonite. A mineralogical synonym of the *Wavellite* or *Hydrargyllite* which is found at Barnstaple in Devonshire.

Dew (Ger. thau). The deposition of water from the atmosphere, occasioned by cold. The phenomena of dew have been considered by all writers on meteorology, from Aristotle downwards; but they were first successfully investigated by Dr. Wells in 1814.

The circumstances which influence the production of dew are the following: Dew is never abundant except during calm and serene nights. It is, however, frequently observed in small quantities, on windy nights if the sky is clear, and on cloudy nights if there is no wind; but it is never seen on nights which are both cloudy and windy at the same time. If, in the course of the night, the weather, from being calm and serene, should become windy and cloudy, not only will no more dew be formed, but that which has been already formed will disappear, or at least diminish considerably. In calm weather, if the sky be partially covered with clouds, more dew will appear than if it were entirely covered, but less than if it were entirely clear. A very slight motion of the air is rather favourable than otherwise to the formation of dew. On two nights equally calm and serene, the quantities of dew deposited may be very unequal. If rain has fallen recently, it will be formed in abundance; on the contrary, very little will be formed in nights otherwise favourable, if the weather has been dry for some time previously. In general, whatever tends to increase the quantity of moisture in the atmosphere will contribute to render the deposition of dew more abundant. Dew is commonly more plentiful in spring and autumn than in summer; the reason is, that the differences of the temperatures of the day and night are greater in the former seasons of the year than in the latter. It is always most copious on those clear and calm nights which are followed by misty or foggy mornings; the formation of the fog showing that the atmosphere had previously contained much moisture. It is unusually plentiful on a clear morning succeeding a cloudy night. The notion that dew is only formed in the morning and evening is incorrect; bodies are covered with dew at all hours of the night, provided the sky be serene. In this country dew generally begins to appear upon grass, in places shaded from the sun, during clear and calm weather, soon after the heat of the atmosphere has declined; that is, three or four hours after midday. Grass is frequently felt to be moist, in dry weather, several hours before sunset; but dew is scarcely ever formed in visible drops before the sun is near the horizon, and is never copious till some time after sunset. Other circumstances being equal, less dew is formed during the first half of the night than during the second, although the air, at midnight, has already lost a certain portion of its moisture.

Polished metals attract the least quantity of dew; and when formed upon them, it will often disappear, while other substances in the neighbourhood remain wet; and a metal which has been purposely wetted will often become dry, though similarly exposed with bodies that are contracting dew. This inaptitude of the metals to attract dew is communicated to bodies of a very different nature which touch or are near them: for example, wool laid upon a metal will acquire much less dew than an equal quantity laid upon grass in the immediate vicinity; and, conversely, bodies on which the metals are laid have an influence on the quantity of dew which the latter will attract. The metals do not all resist the formation of dew with the same force. Dr. Wells one night saw platinum distinctly dewed, while gold, silver, copper, and tin, though similarly situated, were entirely dry; and he several times saw these four metals free from dew, while iron, zinc, and lead were covered with it.

Difference in the mechanical state of bodies, though the other circumstances be similar, has an effect on the quantity of dew which they attract. Thus, more dew is formed upon fine shavings of wood, than upon a thick piece of the same substance; and raw silk, cotton and flax, were found to attract more dew than the wove material.

The quantity of dew precipitated on bodies is also influenced by their situation in regard to surrounding objects. As a general principle, it may be affirmed that whatever tends to diminish the portion of the sky which can be seen from the place which the body occupies,

diminishes the quantity of dew with which it will be covered.

Of the Cold connected with the Formation of Dew.—The temperature of grass covered with dew is always lower than that of the surrounding air. On calm and clear nights, Dr. Wells frequently found the grass 7°, 8°, or 9°, and on one occasion 14°, colder than the air about four feet above it. He also observed that in places sheltered from the afternoon sun, but still open to a considerable portion of the sky, the difference between the temperature of the grass and the air begins to be sensible as soon as the heat of the atmosphere begins to diminish. In analogous circumstances, a similar coldness continues on grass, in still and serene mornings, for some time after the rising of the sun. In cloudy nights, particularly if there was wind, the grass was never much colder than the air; sometimes it was even warmer: but in calm weather, very high clouds, though sufficiently extensive and dense to conceal the sky, would yet frequently allow of the grass being several degrees colder than the air. If the night became cloudy, after being very clear, the temperature of the grass immediately became higher. The temperature of metals sometimes falls from 2° to 4° below that of the surrounding air; when this takes place, other bodies, such as wool, swan-down, the leaves of plants, &c., are considerably colder than the atmosphere. The substances which are most easily covered with dew are those which are cooled down the quickest when exposed to a clear sky. Of the substances tried by Dr. Wells, swan-down and other filamentous and downy materials exhibited the greatest cold.

Theory of Dew.—Dr. Wells's experiments show that the most perfect analogy subsists between the faculty which bodies possess of attracting moisture from the atmosphere, and the other property which they have of acquiring, in calm and clear nights, a temperature much below that of the surrounding air. But is the cold, which is observed on bodies covered with dew, the cause or the consequence of its precipitation? The latter opinion was maintained by Dr. Wilson of Glasgow, in a paper on hoar-frost inserted in the first volume of the *Transactions of the Royal Society of Edinburgh*. But it has been clearly established by Dr. Wells that the cold is the cause of the dew; for he found, 1st, that in certain circumstances bodies would become colder than the air without being dewed, whence it is obvious that the cold could not be the effect of the dew; and, 2nd, that when dew was formed, its quantity and the degree of cold that appeared with it, at different times, were very far from being always in the same proportion to each other. He also invariably found that bodies became colder before dew began to appear on them. The formation of dew is therefore a phenomenon precisely of the same kind as the precipitation of moisture which takes place on the outside of a vessel into which a liquid colder than the air is poured. It is well known that atmospheric air, at every different degree of temperature, can contain only a determinate quantity of water, and that the quantity is greater as the temperature is higher. If, then, a stratum of air has its temperature lowered by coming into contact with a body colder than itself, a portion of its water will immediately be precipitated. A second stratum of air succeeds the first, is cooled down in its turn, and abandons that portion of its moisture which its decreased temperature does not permit it to retain. The phenomenon is repeated with great rapidity, and in a short time the *cooling* body is covered with dew or moisture. As soon as it was proved that bodies exposed to the clear sky acquire a temperature lower than that of the adjacent atmosphere, the origin of the moisture with which their surfaces become covered could not be mistaken.

In order to render this theory complete, it only remains to explain the cause why bodies, when exposed to the cloudless sky in clear and calm nights, become colder than the surrounding atmosphere. Since the laws of the radiation of heat were established by the experiments of Leslie and Rumford, the rationale of this phenomenon has been well understood. During calm and serene nights, the upper parts of the grass radiate their heat into the regions of space, from which they receive back no heat in return: its lower parts, from the smallness of their conducting power, transmit little of the earth's heat to the upper parts, which at the same time receiving only a small quantity from the atmosphere, and none from any other lateral body, must remain colder than the air, and condense into dew its watery vapour, if this be sufficiently abundant.

This explanation is grounded on the hypothesis of M. Prevost, of Geneva, respecting the constant radiation of heat by bodies in contact with the atmosphere, even at the time when they are exposed to the influence of bodies warmer than themselves: but the hypothesis has not been universally admitted; and Sir J. Leslie, on the contrary, ascribes the effect to the descent of cold air from the upper regions of the atmosphere. 'The application of the æthrioscope,' he remarks, 'has not only ascertained the existence, but measured the intensity, of the cold pulses which are at all times darted downwards from the successive strata of air, though often partially intercepted by clouds, or more completely obstructed by low fogs. It may be computed that in fine bright evenings those cold pulses, rained from the sky, are sufficient alone to depress the temperature of the ground, according to the seasons, sometimes eight degrees, but generally about three degrees of Fahrenheit's scale. The blades of grass, thus chilled from exposure, cool in their turn the damp air which touches them, and cause it to drop its moisture.' (*Encyclopædia Britannica*, art. 'Dew.')

It may be added, that among all the phenomena connected with the formation of dew, there is not one which does not admit of a satisfactory explanation on the principle esta-

blished by Dr. Wells; namely, that dew is never deposited on the surface of bodies till they have been previously cooled by their radiation towards space.

Dew Point. The degree indicated by the thermometer when dew begins to be deposited from the air. The instruments used for the determination of the dew point are termed HYGROMETERS [which see].

Dewberry. The fruit of *Rubus cæsius*, so termed from the resemblance which the bloom or waxy secretion upon its surface bears to dew.

Dexiariæ. A family of Dipterous insects, which subsist chiefly on the juices of flowers. The typical genus is *Dexia*; the other genera included in the family are *Teuxia*, *Dinera*, *Scotiptera*, *Rutila*, *Gymnostyla*, *Omalogaster*, and *Prosena*.

Dextrin (Lat. dextra, *the right hand*). In Chemistry, means the soluble or gummy matter into which the interior substance of starch globules is convertible by *diastase*, or by certain acids. Its chemical formula is $C_{12}H_{10}O_{10}$. It is remarkable for the extent to which it turns the plane of polarisation to the *right* hand, whence its name. The term is also applied to starch which by exposure to heat has been rendered soluble in cold water. This artificial or *British gum*, as it has sometimes been termed, is largely used as a substitute for gum arabic. It is employed for stiffening calicoes, for sizing paper, and for the adhesive layer at the back of postage stamps. Starch is also converted into dextrin by the action of the saliva, pancreatic juice, and some other fluids.

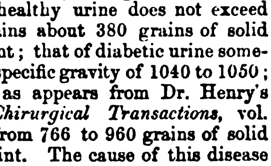
Dextroracemic Acid. *Dextrotartaric acid.* The ordinary tartaric acid of commerce is so called because it causes right-handed rotation of a ray of plane polarised light.

Dey (derived by some from the Turkish dai, *a maternal uncle*). A Turkish title of dignity, given to the governors of Algiers (before the French conquest), Tunis, and Tripoli. The dey is chosen for life from among the chief authorities of the place, with the approbation of the Turkish soldiery. At Tunis the equivalent title of *bey* is more usually substituted for *dey*.

Diabase. A mineralogical synonym of greenstone.

Diabetes (Gr.). An immoderate flow of urine. There are two varieties of this disorder; the one is merely a superabundant discharge of ordinary urine, and is termed *diabetes insipidus*; in the other the urine has a sweet taste, and contains abundance of that modification of saccharine matter termed *glucose*: it is called *diabetes mellitus*. This disease usually attacks persons of a debilitated constitution towards the decline of life, and generally without any obvious cause. Thirst and a voracious appetite are its first symptoms; the urine gradually increases in quantity; and then there is a sense of weight and uneasiness in the loins, emaciation, œdematous legs, and hectic fever. In *diabetes mellitus* the quantity of saccharine matter is generally such, especially where the disorder has been of long standing, as materially to increase the specific gravity of the urine; and this accordingly forms a useful criterion of the state of the disease, for whatever tends to diminish the specific gravity of the urine is at the same time diminishing its saccharine contents: an hydrometer therefore is useful in determining this point. The specific gravity of healthy urine does not exceed 1020, and contains about 380 grains of solid matter in the pint; that of diabetic urine sometimes attains a specific gravity of 1040 to 1050; in which case, as appears from Dr. Henry's table (*Medico-Chirurgical Transactions*, vol. ii.), it contains from 766 to 960 grains of solid matter in the pint. The cause of this disease is unknown; nor has dissection thrown much light upon it, for in some cases no morbid state of the viscera is observed; in others, however, the kidneys are flabby, pale, and enlarged, or more vascular than they should be: the lacteals are also sometimes thickened, and the mesenteric glands enlarged. There are very few cases on record of the cure, or even of the relief, of confirmed diabetes. Where it is symptomatic of hysteria, dyspepsia, or hypochondriasis, the usual remedies for those affections are useful; but where it is *idiopathic*, and saccharine, nothing has proved decidedly serviceable. Strict abstinence from vegetable food of every kind, and the free exhibition of opium, are the only plans which have held out hopes of success; but there are very few cases upon record in which these seem to have been permanently successful.

Diacaustic Curve. In the Higher Geometry, the *caustic by refraction*. It is generated as follows: If rays P *m* issuing from a luminous point P be re-



fracted by the curve A *m* B, so that the sines of incidence are to the sines of refraction in a given ratio, the curve C D H, which touches all the refracted rays, is called the *diacaustic*, or caustic by refraction. [CAUSTIC.]

Diachylum or **Diachylon** (Gr. διάχυλος, *juicy*). A celebrated plaister of former days made of the juices of several plants; the term is still retained, and applied to common plaister, made by boiling hydrated oxide of lead with olive oil.

Diaclasite (Gr. διακλάω, *to cleave in two*). A variety of Augite, intermediate in composition between Diallage and Hypersthene. It is found in Bavaria; in the Harz; and in the Guadarama Mountains of Spain.

Diacodium (Gr. διά, and κωδία, *a poppy*). A preparation of the poppy. Syrup of white poppies was formerly called *syrup of diacodium*.

Diacope (Gr. *a gash* or *cut*). A genus of spiny-finned fishes of the Perch tribe, allied to *Serranus*; but distinguished by a notch at the

lower part of the preoperculum, to which a projecting tubercle is adapted.

Diacoustics (Gr. διά, and ἀκούω, *I hear*). That branch of Physics which treats of the properties of sound refracted in passing through media of different densities. [SOUND.]

Diacritic Marks (Gr. διακριτικός, *able to distinguish*). In Palæography, marks used to distinguish letters, between the forms of which much similarity exists. Thus *n* and *u* are distinguished in German running hand by the mark ᴗ over the latter letter.

Diadelphous (Gr. διά, and δελφύς, *a womb*). In Botany, a term applied to stamens the filaments of which have coalesced into two masses or brotherhoods, as in *Fumaria* and many leguminous plants.

Diadem (Gr. διάδημα, from δέω, *I bind*). Originally a fillet wound round the temples, probably imported into Greek costume from the East. It was the symbol of royalty among various Oriental nations. The diadem of Bacchus, from the representation in ancient statues, &c., was a broad band, which might be unfolded so as to form a veil. Constantine the Great was the first Roman emperor who used the diadem; after his time, it was set with rows of pearls or precious stones.

Diæresis (Gr. διαίρεσις, from διαιρέω, *I divide*). In Grammar, the resolution of a diphthong, or a contracted syllable, into two syllables: as in Latin, auraï for auræ, &c.; and, in English, the resolution of the last syllable of participles by giving a sound to the final *e*; belovëd, cursëd, &c. [METAPLASM.]

Diagnosis (Gr.). The art of distinguishing one disease from another. The characteristic symptoms of diseases, by which they are recognised, are termed their *diagnostic symptoms*.

Diagometer (from Gr. διάγω, *I lead through*, and μέτρον). An electric instrument for determining the conducting power of fixed oils, and especially for the detection of adulteration of olive oil, which is said to have the lowest conducting power of such oils.

Diagonal (Gr. διαγώνιος, from γωνία, *an angle*). A straight line drawn through a figure, joining two opposite angles. The term is chiefly used in Geometry, in speaking of four-sided figures; but it is also properly applied with reference to all polygons of which the number of sides is not less than four. Euclid uses the term *diameter* in the same sense; but modern geometers use *diameter* only when speaking of curve lines, and *diagonal* when speaking of angular figures. [QUADRANGLE and QUADRILATERAL.]

Diagonal Eye-piece. An eye-piece used in sun-observations. [EYE-PIECE.]

Diagram (Gr. διάγραμμα, from διά, through, and γράφω, *I write*). The figure or scheme drawn for the illustration of a mathematical proposition, or the demonstration of any of its properties.

Diagridium or **Dacrydium** (Gr. δακρύδιον, dim. of δάκρυ, *a tear*). An obsolete name of scammony in drops or tears, and of some old preparations containing that drug.

Dial or **Sun-dial.** An instrument for showing the hour of the day by means of the sun's shadow. The invention and use of sun-dials are of the highest antiquity. According to Herodotus, the Greeks learned the use of them from the Chaldeans; and the first of which history makes mention is the hemisphere of Berosus, who is supposed to have lived about 540 years before Christ. The sun-dial and the clepsydra were the only instruments known to the ancients for the measurement of time.

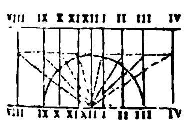
In constructing a sun-dial, the object is to find, by means of his shadow, the sun's distance at any time from the meridian. When this distance is known, the hour is also known, provided we suppose the sun's apparent motion to be uniform, and that during the whole course of a day he moves in a circle parallel to the equator. Neither of these conditions is, in fact, accurately fulfilled, but the error which this gives rise to is of small amount; and it is, moreover, sufficiently obvious that the use of a dial is not to indicate the hour with astronomical precision, but merely to give such an approximation as is necessary for the purposes of civil life.

Dials are usually constructed on an immoveable surface, and admit of an infinite number of different constructions, all depending on the nature of the surface and its position with regard to the equator of the earth. The general principles, however, are the same in all, and depend on the simplest elements of geometry and astronomy. The first part that claims attention is the *style* or *gnomon*, or axis of the dial, which is usually a cylindrical rod, or the edge of a thin plate of metal. The style must be parallel to the earth's axis; and being so, it may be considered, on account of the smallness of the earth's diameter in comparison of the distance of the sun, as coinciding with the axis of the diurnal rotation; consequently the plane which passes through the centre of the sun, the style, and its shadow if a rod, or the limit of shadow of an edge, will be an *hour plane*, and turn with the sun, as the sun turns round the style by the effect of the diurnal motion. All that remains to be done, in addition, is to discover, and describe, for the different hours of the day, the intersections of this variable hour plane with the surface on which the dial is to be constructed. On these intersections the shadow of the style will be projected every day at the same hour; because at the same hour the sun returns daily to the same hour plane, although his distance from the equator may be different.

From these considerations it is manifest that the whole theory of dialling is comprehended in the solution of this general problem: 'Twelve planes all intersecting each other in the same straight line, and making with each other equal angles of 15°, being given in position; to find the intersections of those planes with any sur-

face whatever, also given in form and position.' The surface which intersects the hour planes may be of any kind whatever, but for obvious reasons it is generally a plane; and when its position with respect to the common intersection of the hour planes (which is the style of the dial) and to any one of those planes is given, the *traces* or intersections, which are in this case all straight lines, are the *hour lines* on the dial, and easily determined by the ordinary rules of trigonometry or geometry.

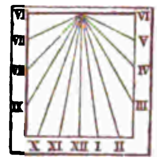
According to the position of the plane of the dial with respect to the horizon of the place, the dial is *horizontal*, *vertical*, or *inclined*. The simplest case of all is that in which the plane of the dial is parallel to the axis of the earth, and perpendicular to the meridian of the place. In this case the style is also parallel to the plane of the dial, and the hour lines are parallel straight lines, whose distances from the meridional line are respectively proportional to the tangents of the angles which the hour planes make with the plane of the meridian. This is called a *Polar Dial.*



The most common construction is the *Horizontal Dial*, or that in which the plane of the dial is parallel to the horizon, and consequently makes with the style an angle equal to the latitude of the place. At the equator, this is the same as the polar dial, which has just been described; but at all other places, the hour lines intersect each other in the point in which the style intersects the plane of the dial, which point is called the *centre*, and the angles they make with one another, or with the meridional line to XII, depend upon the latitude. The following table shows the angles which the different hour lines of a horizontal dial make with the meridional line, at the latitude of London, or 51½°:—

Morning	Afternoon	
XI.	I. . . .	11° 51′
X.	II. . . .	24 19
IX.	III. . . .	38 3
VIII.	IV. . . .	53 35
VII.	V. . . .	71 6
VI.	VI. . . .	90 0

After the horizontal dials, the construction most frequently employed is that in which the plane of the dial is vertical; for example, when fixed on the wall of a house. In this case, the positions of the different hour lines depend on the latitude of the place and on the aspect of the dial; that is to say, its position with respect to the meridian. If the dial is perpendicular to the meridian, it is a *south dial*, or *north dial*, according as it faces the south or north. (The vertical south dial is represented in the annexed figure.) When not perpendicular to the meridian, the vertical dial is said to be *declined*. The determination of the hour lines on a south vertical dial is precisely the same as in the case of the horizontal dial. The only difference is that the angle between the style and the plane of the dial is now equal to the complement of the latitude; whence it follows that a horizontal dial constructed for any given latitude will be a south vertical dial for any place of which the latitude is the complement of the latitude of the former place—a property which was discovered by the Arabians. The hour lines of the vertical north dial are found exactly in the same way as those of the south dial.



When the face of the vertical dial is exactly east or exactly west, its plane is in the meridian, and consequently parallel to the vertical plane in which the style is. The hour lines, therefore, as in the polar dial, are all parallel to one another, the only difference being that in the present case there can be no hour line corresponding to noon, since at that time the hour plane is parallel to the plane of the dial.

When the vertical dial does not face directly one of the four cardinal points, it is called a *declining vertical dial*, and the investigation of the hour lines is somewhat more complicated.

It will be observed that the time indicated by a dial is *solar* time or *true* time, and agrees with *mean* time, or that which is shown by a well-regulated clock, only on four different days of the year. [EQUATION OF TIME.]

It has been supposed that the style is formed by a wire, or the straight edge of a thin plate; but a slit in a plate properly placed, allowing a line of light to pass, will evidently answer the purpose. Sometimes a small hole is preferred; and the hour lines, instead of being described on a plane surface, are sometimes described on the surface of a sphere, or a cylinder or a cone. The reader may find a description of some curious dials in Brewster's edition of Ferguson's *Lectures*. For the history of dialling, see Delambre, *Astronomie Ancienne*, tome ii.; Montucla, *Histoire des Mathématiques*, tome i.

Dialect (Gr. *διάλεκτος*, from *διά*, and *λέγω*, *I speak*). In the philosophical sense of the word, any variety of a common language. Hence German, English, Swedish, &c. are all strictly said to be dialects, as coming all of them from the same original stock. Commonly, however, we limit the application of the term *dialect* to the varieties of a national language; and speak of the dialects of English, French, &c. In Greek the four dialects (Doric, Ionic, Æolic, Attic) were the four written varieties of the language, each possessing a literature of its own. In this respect no modern tongue presents a parallel to the Greek; inasmuch as, in all, one dialect has been arbitrarily adopted as

the standard of polite writing and conversation, and the written works which are extant in the other dialects are regarded merely as exceptions to the general rule.

Dialectics (Gr. διαλεκτική). This name was originally used by Plato as synonymous with *metaphysics*, or the highest philosophy. Strictly speaking, it can only be regarded as a preparatory discipline for such investigations, or at most as a scientific method of prosecuting them. The most splendid examples of dialectical subtilty that exist are to be found in the *Dialogues* of Plato, especially in those entitled *Parmenides, the Statesman and Sophist.* In a narrower sense, dialectics is defined as meaning that portion of logic which teaches the modes and rules of reasoning; and the logic of Aristotle undoubtedly owes its existence to the dialectical exercises of the Platonic schools; and may, in one point of view, be regarded as a body of canons and directions for their legitimate use. [PLATONIC PHILOSOPHY.] In modern times various systems of dialectics have been propounded in different countries; but by no philosophers, either ancient or modern, has this science been more successfully cultivated than by the Germans, who, among a host of other names more or less distinguished, can boast of a Fichte, Kant, Leibnitz, Hegel, Schelling, and Schlegel, as the propounders each of a peculiar dialectical system.

Diallage (Gr. διαλλάσσω, *I interchange*). A mineral of a foliated structure easily divisible in *one* direction, its natural joints and artificial fractures exhibiting a very *different* lustre and appearance.

Dialling Lines or Scales. Graduated lines, on rules or circles, to facilitate the construction of dials.

Dialogism (Gr. διαλογισμός). In Rhetoric, a mode of writing dialogue, in which the conversation of two or more persons is reported in the third person instead of the first. A speech by a single person, or a soliloquy, when reduced into the narrative form, is also, although somewhat incorrectly, termed by French literary writers *dialogism*.

Dialogue (Gr. διάλογος). In Literature, a composition or part of a composition in the form of a conversation between two or more persons. The dialogue was the form most generally adopted by the ancients for the conveyance of instruction, and was considered equally applicable to the most grave and philosophical, and to the most ludicrous and comical subjects. It was adopted by Plato, Cicero, and Lucian, with equal success. Among modern writers the philosophical dialogue has been frequently employed, more especially by the French. Among other eminent persons of that country who have enriched its literature with this species of composition are, Fénelon; Bouhours, in his *Entretiens d'Ariste et d'Eugène*; Fontenelle, in his *Dialogues of the Dead*, and *Plurality of Worlds*; Galiani, *Sur le Commerce des Grains*, &c. In England this method of composition has been less frequently practised; and perhaps, with the exception of Berkeley and Hurd, has rarely succeeded in the hands of those who attempted it. Among the Italian writers of dialogue may be mentioned Machiavelli and Algarotti; and among the Germans, Lessing, Mendelssohn, Schelling, and Herder.

Dialuric Acid. A crystalline acid having the formula $C_8\ H_3\ O_7\ N_2 + HO$, obtained by the action of sulphuretted hydrogen on a boiling solution of alloxan.

Dialypetalous (a word coined from Gr. διαλύω, *to separate*, and πέταλον, *a leaf*). In Botany, a term equivalent to *polypetalous*, and applied to those plants which have distinct petals, in contradistinction to those which have the petals united into what is commonly called a *monopetalous corolla*, but which is more strictly said to be *gamopetalous*.

Dialysis (Gr. διάλυσις). A term applied by Mr. Graham to a process of analysis by diffusion through a septum. The apparatus used in the process is called a *dialyser*, and is constructed and employed in the following manner: The most convenient septum is the commercial article known as *parchment paper*, made by immersing unsized paper for a short time in sulphuric acid. A piece of this material is stretched over a gutta-percha hoop, and secured by a second external hoop. Such dialysers of useful size are one or two inches deep and five to ten inches wide. Liquids to be dialysed are poured into the dialyser, which is then floated in a flat dish containing distilled water.

The practical value of dialysis depends upon the fact that certain substances will diffuse through a given septum far more rapidly than others. Uncrystallisable bodies diffuse very slowly. Of such matters as starch, gum, albumen, and gelatin, the last-named is perhaps least diffusive; hence substances of this class are termed *colloids*, or bodies like *collin*, which is the soluble form of gelatin. Substances which diffuse rapidly are mostly crystalline; hence bodies of this class are termed *crystalloids*.

Aqueous solutions of two parts of the following named substances in 100 parts of water, were dialysed by Mr. Graham for twenty-four hours. The amounts of each substance which passed through the septum bore the following relations to one another:—

Chloride of sodium	1000
Ammonia	847
Theine	703
Salicine	503
Cane sugar	472
Amygdalin	311
Extract of logwood	168
Catechu	159
Extract of cochineal	51
Gallo-tannic acid	30
Extract of litmus	19
Purified caramel	5

The phenomena of dialysis show that crystalloids have a greater affinity for water than

colloids have. If a solution of chloride of sodium be placed at the bottom of a jar, and covered by a hot solution of gelatine of sufficient strength to solidify on cooling, the chloride of sodium will diffuse up into the solid jelly, because the water of the solid jelly has a greater affinity for the salt than it has for the gelatine. The solid jelly may obviously be reduced in thickness, and water placed over it; indeed the conditions would then be still more favourable for diffusion. Replace the stratum of jelly by a permanent colloid, such as parchment paper; the result is the same, the permanent character of the septum admitting of its practical application.

Dialytic Elimination. A method, invented by Sylvester (*Philosophical Magazine*, vol. xxi. 1842), by means of which the resultant of two binary quantics may be expressed as a determinant. [ELIMINATION.]

Diamagnetic. A term applied to bodies which appear to be *repelled* by either pole of a magnet; as opposed to the term *magnetic* bodies, the particles of which are *attracted* by either pole.

Diameter (Gr. διάμετρος, from διά, and μέτρον, *a measure*). In Architecture, the measure across the lower part of the shaft of a column, which is usually divided into sixty minutes, and forms a scale for the measurement of all the parts of an order.

In Astronomy, the *apparent diameter* of a celestial body is the angle which the latter subtends at the eye, and is measured by the micrometer. The distance from the earth, of the body in question, when multiplied by the sine of this angle, gives the real diameter of the body.

DIAMETER. In elementary Geometry, any right line through the centre of a figure. In Conics, a diameter always bisects a system of parallel chords; a fact which appears to have led Newton to a more general definition of a diameter, applicable to curves of all orders. He showed that the *centres of mean distances* [CENTRE OF GRAVITY], upon a system of parallel lines, of the n intersections of each with a curve of any order always lie on a right line, which may be called a *diameter*. Now the centre of mean distances of a number of points *in lines* is nothing more than their *harmonic centre*, of the first order, with respect to an infinitely distant pole [HARMONIC CENTRES], so that Newton's theorem is merely a special case of Cotes' [POLES and POLARS], and a diameter of any curve is simply the *polar line*, with respect to the curve, of an infinitely distant point. This leads naturally to a further extension of the term *diameter*, and to the recognition of $n-1$ *distinct curvilinear diameters* of every curve of the n^{th} order; the r^{th} diameter being simply the r^{th} polar of an infinitely distant point, and consequently a curve of the $(n-r)^{th}$ order. The $(n-2)^{th}$ diameter is called the *diametral conic*, the $(n-3)^{th}$ the *diametral cubic* and so on. (Salmon's *Higher Plane Curves*.)

Precisely the same extension is applicable to surfaces. The diametral r-ic of a given surface of the n^{th} order is the $(n-r)^{th}$ polar, with respect to that surface, of an infinitely distant point. When the primitive surface is of the second order, there is, of course, but one diametral surface, and that is the *diametral plane* which bisects a system of parallel chords. It passes of course through the centre of the surface, and two diametral *planes cut in a diameter*. Three diametral planes, so situated with respect to each other that each bisects all chords parallel to the intersection of the other two, constitute a system of *conjugate diametral planes*, and intersect each other in *conjugate diameters*. In *one* such system the three planes, being perpendicular to each other, are called *principal diametral planes*; they intersect in the three *axes* or *principal diameters* of the surface.

Diametral Curves and Surfaces. [DIAMETER.]

Diametral Plane. [DIAMETER.]

Diamides. Neutral chemical substances derived from ammonia by replacement of two-thirds of its hydrogeh by negative radicals like acetyl, &c.

Diamines. Alkaline substances (artificial alkaloids) derived from ammonia by replacement of two-thirds of its hydrogen by positive radicals like ethyl, &c.

Diamond (a corruption of *adamant*; Gr. ἀδάμας, *unconquerable*, from its extreme hardness and difficulty of fracture). This most valuable of precious stones, and the hardest of known substances, consists of pure or nearly pure carbon. The primary crystalline form of the diamond is a regular octahedron, of which there are many modifications; but it also often occurs in cubes and rhomboidal dodecahedrons, and sometimes in twin crystals; the faces are frequently convex. The most valuable diamonds are perfectly colourless and transparent; but those which are of decided tints of pink, green, or blue are much prized, while those which are only slightly coloured are held in least estimation. They are found in a detached state in alluvial deposits, from which they are extracted by washing. Diamonds were originally discovered in Bengal, and in the island of Borneo. The most celebrated mines of India were those of Golconda, and of Roalcondal in the Mahratta empire. In 1728 they were found in Brazil, and since that time the mines of Minas Geraes have produced most of the stones imported into Europe.

The art of cutting and polishing diamonds was discovered in 1456, by Louis van Berquen, a citizen of Bruges, who found that by rubbing two diamonds together their surfaces might be abraded. At the present time diamond-cutting is principally carried on by Jews at Amsterdam. They are cut chiefly into two forms, called *brilliants*, and *rose-diamonds* or *rosettes*, and sometimes into what are called, from their flat surface, *table-diamonds*. The brilliant form, which has from 56 to 64 facets, was first introduced by Cardinal Mazarin, in 1650. It is especially calculated to bring out the lustre and

refractive powers of the gem. Thus a well-cut brilliant, held in a beam of light, reflects nearly the whole of the light which falls upon it, throwing it out and refracting it in coloured rays through the facets in front. With the exception of one small point of light through the *collet*, the brilliant forms an opaque shadow on a screen.

The largest known diamond is probably that mentioned by Tavernier as belonging to the Great Mogul. It was found in 1550 in Golconda; and in its original state is said to have weighed 900 carats. Among the crown jewels of Russia is a magnificent diamond, weighing 194 carats: it is of the size of a pigeon's egg, and was purloined from a Brahminical idol by a French soldier; it passed through several hands, and was ultimately bought by the Empress Catherine for the sum of 90,000*l*. and an annuity of 4,000*l*. One of the most perfect diamonds hitherto found, is a brilliant brought from India by a gentleman of the name of Pitt, who sold it to the regent duke of Orleans for 125,000*l*. It weighs $136\frac{1}{4}$ carats (430·55 grains). Another very celebrated diamond is the Koh-i-noor (*the hill of lustre*), which became the property of her majesty on the annexation of the Punjaub by the East India Company in 1850. It is mentioned by Tavernier, in 1665, as the property of the Mogul emperor, and together with the Doriainoor (*or the ocean of lustre*), another stone nearly as valuable, formed part of the plunder seized by Nadir Shah at the taking of Delhi in 1739. When brought to this country it weighed $186\frac{1}{16}$ carats, but it has since been recut by the Messrs. Garrard, and although the weight of the stone has been reduced to $103\frac{3}{4}$ carats, its brilliancy and general appearance have been greatly improved.

The diamond was first proved to be combustible in 1794, by the Florentine Academicians, who found that, when exposed to the heat of the sun concentrated in the focus of a large lens, it burnt away with a blue lambent flame. The *products* of its combustion were first examined by Lavoisier in 1772, who showed that when burnt in air or oxygen it produced carbonic acid. Subsequent experiments have demonstrated that nothing but carbonic acid is thus formed; and hence it is proved that the diamond is charcoal or carbon in a pure and crystalline form.

Diamond. In Printing, an exceedingly small type, five sizes smaller than that used in this work, and the smallest usually cast by the British type-founders. It was originally introduced for very small editions of the Bible. [Type.]

Diana. In Mythology, the name of a Latin goddess (the feminine form of Dianus or Janus), whom, however, the Latins soon identified with the Greek goddess Artemis. The latter, in the Hesiodic *Theogony*, is described as the daughter of Zeus and Leto (Latona), and the sister of Apollo or Hecatus, the far-shooter. She shares his attributes of destruction and healing, but not those of music and prophecy. She is also one of the three goddesses who are described as ever virgin: the other two being Athena (Minerva) and Hestia (Vesta). (Homer, *Hymn to Aphrodite*, 8–24.) She is in fact the growth of that subdivision of attributes, which out of the Indra or Sun, of Sanscrit mythology, evolved the several persons of Apollo, Artemis, Helios, Hyperion, Phaethon, &c. The Ephesian Artemis, whose worship throughout the Asian district is spoken of in the Acts of the Apostles, seems to be an entirely different goddess, whose chief work was that of natural reproduction. The well-known temple of this goddess at Ephesus was set on fire by Eratostratus on the day on which Alexander the Great was born. It was rebuilt, but destroyed again A.D. 260.

Diana, Tree of. A name given by the old chemists to the crystallised silver which is separated when mercury is put into a solution of nitrate of silver.

Diandrous (Gr. δίς, and ἀνήρ, *a man*). In Botany, a term applied to any plant having but two stamens.

Dianic Acid. This term has been applied to the oxide of a metal said to be allied to Niobium.

Diapason (Gr. *through all*). In Music, an interval used by most authors to express the octave of the Greeks. For an account of the diapason in the organ pipes, see Organ.

By the French this term is used as an equivalent to our word *pitch*; and also to denote a pipe, fork, or other instrument by which the pitch is determined.

Diapensiaceæ (Diapensia, one of the genera). A group of corollifloral Exogens of the Gentianal alliance, consisting of prostrate undershrubs, found in the northern parts of Europe and North America. Their peculiar features are the absence of stipules, intermediate stamens, simple stigmas at the end of a manifest style, axile placentæ, and indefinite seeds.

Diapente (Gr. from διά, and πέντε, *five*). In Music, an ancient term signifying a fifth.

Diaper (Fr. diapré). A woven linen ornamented with patterns, and used for towels and table linen; it sometimes resembles an inferior kind of damask. It is said to have been originally manufactured at Ypres in Flanders, and hence to have received its name.

Diaper. A term used to signify the repetition of a pattern of any flowers, foliage, or geometrical form of ornamentation, over a large surface of work; it differs from *chequers* inasmuch as the latter is applied to a repetition of geometrical figures which are indicated by rectangular or diagonal lines intersecting one another at fixed intervals.

Diaphanous (Gr. διαφανής, *transparent*). A term applied to bodies which, like porcelain, permit the light to pass through their substances. It is the synonym of *translucent*. A body which allows the distinct forms of objects to be seen through it is *transparent*.

Diaphonics (Gr. διά, and φωνή, *sound*). The doctrine of refracted sound. [SOUND.]

Diaphoresis (Gr.). A perspiration: hence also *diaphoretics*, medicines which promote perspiration.

Diaphoretic Antimony. In old Pharmacy, a term applied to the peroxide of antimony, and also to the antimoniate of potassa.

Diaphragm (Gr. διάφραγμα, literally *a partition*). In Conchology, this term is applied to the straight calcareous plate which divides the cavity of certain shells into two parts. In Anatomy, its common signification relates to the muscular and tendinous partition which separates the chest from the abdomen in mammalia. This term is also applied to the stop in a photographic camera, and the perforated circular plates used in telescope and microscope tubes to allow only the light from the object-glass to reach the eye-piece.

Diaphragm Shell. [SHRAPNEL SHELL.]

Diapophysis (from Gr. ἀπόφυσις, *an offshoot* or *process*). In Anatomy, the upper of the two transverse processes which project from the sides of the cervical and anterior dorsal vertebræ of the crocodile, and which is usually anchylosed with a rudimental rib in the cervical vertebræ of birds and mammals; in these it forms the sole 'transverse process' of the succeeding vertebræ, and is usually developed from the neural arch.

Diarrhœa (Gr. διάρροια, *a flowing through*). A purging or looseness of the bowels. There are several varieties of diarrhœa, depending upon different causes, and consequently requiring in many instances distinct modes of treatment. In general it is necessary first to remove offending and irritating matters from the bowels by means of aperients; rhubarb, from its astringent tendency, is the purgative usually employed; afterwards astringents with warm aromatics, and the occasional addition of some form of opium, are prescribed and continued till the inordinate laxity of the bowels is quelled. Where diarrhœa is connected, as it often is, with excess of acidity in the stomach, magnesia, chalk, or carbonated alkalies are united to the other remedies.

Diarthrosis (Gr. *articulation*). The movable connection of bones.

Diary (Lat. diarium, literally *a daily allowance*). This term signifies properly a note-book or register of daily occurrences, in which the writer has a principal share, or which have come under his own observation, or have happened in his own time. The term *diary* is equivalent to the French *journal*, the Italian *diario* and *giornale*, and the German *Tagebuch*.

Diaschisma (Gr. διασχίζω, *I cleave*). In Music, an interval consisting of two commas.

Diaspore (Gr. διασπείρω, *to scatter*). A mineral which is usually found in thin flattened prisms (sometimes acicular) or in slightly curved laminæ. It is a hydrate of alumina. Small pieces decrepitate and are dispersed in numerous fragments, when heated in the flame of a candle or before the blowpipe; hence its name.

Diastase (Gr. διά, and ἵστημι, *I place*). A white amorphous substance generated during the germination of barley, wheat, &c. which tends to accelerate the formation of sugar during the fermentation of worts. It is precipitated from infusions of bruised malt by alcohol. It is the principle which by its reaction on starch tends to its conversion into dextrine and glucose, one part of it being sufficient for the conversion of 2,000 parts of starch.

Diastem (Gr. διάστημα). In Ancient Music, a simple interval as distinguished from a compound one; to which latter was given the name of a *system*.

Diastema (Gr.). In Zoology, the vacant space occurring in the dental series by the absence of the canine or laniary teeth.

Diastole (Gr. from διά, and στέλλω, *I place*). The dilatation of the heart and arteries.

Diastyle (Gr. διάστυλος). In Architecture, that mode of arranging columns in which the space between two consecutive columns consists of three diameters, or, according to some, of four diameters.

Diatessaron (Gr. from διά, and τέσσαρες, *four*). In Ancient Music, the interval of a fourth.

DIATESSARON. In Ecclesiastical History, this name is given to Harmonies of the Gospels, of which the earliest was that of Tatian, in the second century. This work has long been lost.

Diathermal or **Diathermanous** (Gr. διά, and θέρμη, *warmth*). A term applied to certain substances, such as transparent pieces of rock-salt, &c., which suffer radiant heat to pass through them, much in the same way as transparent or *diaphanous* bodies allow of the passage of light.

Diathesis (Gr. *a disposition*). A particular state of constitution predisposing to certain diseases: such as inflammatory, nervous, and putrid diathesis; uric diathesis, in which there is excess of uric acid thrown off by the kidneys; gouty diathesis, &c.

Diatomaceæ (Diatoma, one of the genera). A group of *Algæ*, of low organisation, closely related to *Desmidiaceæ*, but remarkable for the enormous quantity of silex which they contain. Vast beds occur, many feet in thickness, consisting entirely of effete frustules, as the separate joints of the fronds are called. These beds are known by the name of *Tripoli*, and afford an admirable article for polishing. They occur again in the form of white powder, known as *Mountain Meal*, which is mixed with flour in some parts of Sweden. The *Diatomaceæ* form a large portion of the food of some of the lower molluscs. They occur in all parts of the world, enduring extreme degrees of cold without annihilation, and are found also in springs of high temperature. For further information, see Smith's *Diatomaceæ*, and the Rev. M. J. Berkeley's *Cryptogamic Botany*.

Diatonic (Gr. διατονικός, from διά, and τόνος, *a tone*). In Music, a term denoting the

natural scale of music, which, proceeding by degrees, includes both tones and semitones.

Diatonic Scale of Colours. Newton found, or supposed, that the spaces occupied by the seven primary colours in the solar spectrum are exactly proportional to the length of strings that sound the seven notes in the diatonic scale of music. It is now known, however, that the relative lengths of the spaces occupied by the different colours in the spectrum depend on the nature of the substance of which the refracting prism is formed. [CHROMATICS.]

Dibble. In Agriculture and Horticulture, a cylindrical piece of wood from one to two inches in diameter, and from 1 ft. to 2 ft. in length, having a cross or loop handle at one end, and brought to a conical point at the other, for the purpose of making holes in the ground to receive plants or seeds. Dibbles which are used for planting potatoes or beans are commonly from two to two and a half feet in length, with a peg inserted near the ground in order that the operator may press it with his foot.

Dibothrians, Dibothri (Gr. δίς, and βόθρος, *a pit*). The name of a division of tapeworms, including those *Bothriocephali* which have not more than two pits or fossæ on the head.

Dibranchiates, Dibranchiata (Gr. δίς, and βράγχια, *gills*; *two-gilled*). The name of the order of Cephalopods which includes those with two gills, and which are also characterised by having three distinct hearts; an apparatus for secreting and emitting an inky fluid; cephalic arms, never exceeding ten in number, solid, and supporting acetabulæ; and in short all the chief characteristics which are usually ascribed to the entire class of Cephalopods. The same term (*Dibranches*) is applied by Latreille to an order of the class *Cirripedia*, comprehending those species which are similarly characterised by having two gills.

Dicast (Gr. δικαστής, from δίκη, *justice*). A certain number of Athenian citizens, chosen annually by lot to represent the whole body of the people, while performing certain judicial functions, were called *dicasts*. In their being so selected, and in their oath that they would rightly discharge the duties of their office, they bore some resemblance to our jurors; but here the likeness ceased. The dicasts received pay; and none could be elected under thirty years of age, and unless they possessed the full franchise. The number of persons chosen annually for this office was 6,000. The whole body of dicasts was termed *dicasterion*, and the same name was applied to the place in which they sat.

Dice Coal. A species of coal easily splitting into cubical fragments.

Dicerates, Dicerata (Gr. δίς, *double*, and κέρας, *horn*; *two-horned*). A name applied by De Blainville to a family of the order *Paracephalophora Polybranchiata*, comprehending all such Gastropodous Molluscs as have two tentacles on the head. The term *Diceras* was previously applied by Lamarck to a fossil genus of Bivalves.

Dichlamydeous (Gr. δίς, and χλαμύς, *a garment*). In Botany, a term applied to plants having both calyx and corolla.

Dichloraniline. Aniline, in which two equivalents of hydrogen are replaced by chlorine.

Dichobune (Gr. δίχα, *apart*, and βουνός, *hill*). A genus of even-toed (artiodactyle) mammalia which has been discovered in the Upper Eocene beds of Hampshire. It is closely allied to *Anoplotherium* and *Xiphodon*; unlike those genera, there is, however, a slight interval between the canine and the first premolar in both jaws.

Dichodon (Gr. δίχα, and ὀδούς, *tooth*). In this genus, allied to *Anoplotherium* and *Dichobune*, the dental series is continuous without break—a character which amongst existing mammals is manifested by mankind alone: the crowns of the teeth in *Dichodon* being all of nearly equal height, as they are in man. The *Dichodon cuspidatus* was as large as a fallow-deer.

Dicholophus (Gr. δίχα, and λόφος, *a crest*). The name of the genus of wading birds (*Grallatores*), including the *Cariama*, which is characterised by a tuft of feathers projecting from the crown of the head in two directions.

Dichotomous, Dichotomus (Gr. διχότομος). Signifies the division of an object by repeated bifurcation, so that the branches are always in pairs.

Dichotomy (Gr. διχοτομία). An artificial system for the arrangement of natural objects based upon principles of binary distinction.

In Logic, the division of a class into two sub-classes which are opposed to each other by contradiction. The reduction can be made at each stage of any division, however complex.

Dichroism (Gr. δίς, *twofold*, and χροιά, *colour*). In Mineralogy, this term is applied to those minerals which present different colours, when viewed by transmitted light, in two different directions; the colours being the same in the direction of like axes, and different in that of unlike axes. Iolite is an example of this property, and the name *Dichroite* has been given to it in consequence. Mica affords another instance, being nearly opaque when viewed in one direction, but transparent and of a different colour in another. A good instance of dichroism occurs in the crystals of chloride of palladium, which appear of a deep red colour along the axis, and of a vivid green when viewed in a transverse direction.

Dichroite (Gr. δίς, and χροιά, *colour*). A mineralogical synonym for Iolite, in allusion to its dichroism, or display of different colours when viewed by transmitted light in different directions. [DICHROISM.]

Diclinous (Gr. δίς, and κλίνη, *a bed*). In Botany, having the stamens and pistil separated, that is to say, situated in separate flowers, sometimes on the same plants, sometimes on distinct plants.

Dicompounds. The prefix *di* to a chemical compound generally implies that it contains two atoms of base, or electro-positive element, to one of salifying or electro-negative element. Dicarbonate of copper, for instance, is a compound of two atoms of oxide of copper with one atom of carbonic acid; dichloride of mercury, a compound of two atoms of mercury and one of chlorine, &c.

Dicotyledons (Gr. δίς, and κοτυληδών). One of the primary classes of the vegetable world, consisting of all those plants that have their embryo furnished with two cotyledons, or with a greater number arranged on the same plane. These plants are also called *Exogens.*

Dictator (Lat.). In Roman History, an extraordinary magistrate, invested with absolute power for the period of six months. The office seems to have existed in many Latin towns before it was introduced into Rome. Of the reasons for its introduction into the latter state we have very inconsistent accounts. According to some, T. Lartius was the first dictator; according to others, M. Valerius. Livy ascribes the appointment to the exigencies of a Latin war; Dionysius affirms that it was owing to the discontent of the plebeians, who refused, until relieved of their debts, to serve in the army. Niebuhr's idea that the Roman dictator, as holding office for six months, was head of a Roman and Latin confederation, while a Latin dictator had supreme power for the rest of the year, is mere theory. Dictators were appointed not only when the state was in danger, but sometimes for ceremonial purposes, as for holding the comitia, fixing the *clavus annalis*, &c. They could not legally hold office for more than six months; but they usually resigned it in a few days or weeks. It is very doubtful whether election by the curiæ was necessary to the appointment; but the nomination by the consul was indispensable. The office was at first confined to the patricians; but, like the rest, was in course of time opened to the plebeians, the first plebeian dictator, C. Marcius Rutilus, being appointed B.C. 356. So far as we know, it was not subject to the Valerian law of appeal; but the tribunes of the people continued to discharge their functions during a dictatorship, although all other offices were suspended. The dictator had the appointment of the *magister equitum*, or master of the horsemen, who in his absence exercised dictatorial power. The dictatorships of Sulla and Cæsar were altogether irregular and illegal, and were, in fact, dictatorships only in name.

Dictionary (Mod. Lat. dictionarium). A collection of words in one or more languages, with their peculiar significations, arranged in alphabetical order; but the term may be applied in a more extended sense to any work which professes to give information on an entire subject, or an entire branch of a subject, under words or heads digested in order of the alphabet. Hence dictionaries may be said to be of two sorts—of *words*, and of *facts* or *things*; in the former sense the term *dictionary* being equivalent to *lexicon*, in the latter to *encyclopædia*.

Dictionaries of Words.—No dictionaries belonging to a time before the Christian era have come down to us; and the attempts made to supply the want of such books in the early centuries of Christianity and during the middle ages, were comparatively incomplete. The Greek lexicographer, Suidas, is supposed to have lived in the eleventh century. His lexicon, printed at Milan in 1499, has been of the greatest service to succeeding scholars. It was republished in 1834, in an amended form, by the late Dr. Gaisford, Regius Professor of Greek at Oxford. A great advance was made in 1535 by the publication of the Latin Thesaurus of Robert Stephens (Étienne); and the Greek Thesaurus of his son, Henry Stephen, has furnished the groundwork for all later Greek dictionaries. The honour of possessing the best dictionaries of modern languages belongs to Italy, France, and England. These are the *Vocabulario degli Academici della Crusca*, extended in the latest editions to 6 vols. fol.; the *Dictionnaire de l'Académie Française*, 2 vols. 4to., to which a supplementary volume has been recently added; Johnson's *Dictionary*, 2 vols. fol., 1755; to which must be added the Dictionaries of Dr. Richardson and Dr. Webster. The Spaniards also possess a dictionary of considerable reputation, entitled *Diccionario de la Lengua Castellana, compuesto por la Real Academia Española*, 6 vols. fol. 1726.

Dictionaries of Facts or Things are of two species; being either devoted to separate or single branches of science, art, or literature, or embracing the whole circle of the arts and sciences. Of the former, the *Historical and Critical Dictionary* of Bayle, and the *Dictionnaire de la Bible*, by Dom Calmet, may serve as specimens; and of the latter, the *Encyclopédie Française* and the *Encyclopædia Britannica.* That the idea of comprising all the sciences in a single work was not unknown in antiquity, may perhaps be inferred from the expression ἐγκύκλιος παιδεία, which was used to signify such a course of instruction as should embrace all the sciences. The earliest approximation to this species of literature is to be found in the work of Varro, *Rerum Humanarum et Divinarum Antiquitates*, of which nothing remains but the title; and in the *Historia Naturalis* of Pliny, who has embodied in that work all the results of his multifarious studies and vast erudition. But the term *Encyclopædia* is said to have been first applied to works of this description by some of the Arabian writers of the middle ages, and particularly by Alfarabius, whose general treatise on the sciences is still preserved under this designation. Towards the close of the sixteenth and commencement of the seventeenth centuries, there appeared in Europe several similar treatises with the same title, of which the most celebrated was that of Alstedius, in 2 vols. fol.; but none of these productions can properly be termed dictionaries

or encyclopædias, being merely collections of treatises resembling rather such works as Kett's *Elements of General Knowledge, &c.*, than corresponding to the modern notion of an encyclopædia. The strongest resemblance to the works in question is presented by the *Lexicon Universale Historicum Sacrum et Profanum* of Hofmann, 1677, in 2 vols. fol., and followed in 1683 by a supplement of equal extent; the form of which, at least, has served for a model to nearly all succeeding dictionaries or encyclopædias. It might perhaps be preposterous to assert that Hofmann borrowed the notion of his *Lexicon* from Bacon's theory of the *Encyclopædian Tree*, as set forth in the *Novum Organon*; but, as M. Guizot has observed, there can be little doubt that the great abundance of dictionaries and encyclopædias which the whole of Europe has since witnessed is in some degree owing to that eminent philosopher's classification of human knowledge.

The subjoined list contains a selection of the most valuable productions in this department of literature which have appeared since that time, arranged according to the place and date of their publication.

Great Britain.

1. Lexicon Technicum, or Universal Dictionary of the Arts and Sciences, 2 vols. fol.; the first published 1704, the second in 1710. A supplementary vol. was afterwards added.
2. Chambers's Cyclopædia, 2 vols. fol. 1728. This work was extended in a 7th edit. to 4 vols. fol. 1778–85, by Dr. Rees, who afterwards re-edited the work in 45 vols. 4to. (See *infra*.)
3. An Universal History of Arts and Sciences, &c., by Dr. De Coetlogon, 2 vols. fol. 1745.
4. Barrow's New and Universal Dictionary of Arts and Sciences, 1 vol. fol. 1751; with a supplementary vol. 1754.
5. A New and Complete Dictionary of Arts and Sciences, by a Society of Gentlemen (commonly called Owen's Dictionary, from the name of the publisher), 4 vols. 8vo. 1754.
6. The Complete Dictionary of Arts and Sciences, 3 vols. fol. 1766, by the Rev. Ben. Croker, Dr. Thos. Williams, and Sam. Clark.
7. Encyclopædia Britannica, 3 vols. 4to. 1771. The fifth edition of this work, completed in 1814, was extended to 20 vols.; and a supplement in 6 vols., under the editorship of Mr. Napier, added in 1824. A seventh edition of this work was completed in 1840, under the care of the same editor. The eighth edition, with large additions and improvements, appeared in 1860.
8. The English Encyclopædia, 10 vols. 4to. 1795–1803.
9. The Cyclopædia, commonly known by the name of Rees' Cyclopædia, 1802–19. 45 vols. 4to.
10. British Encyclopædia, 6 vols. 8vo. 1807–9.
11. Encyclopædia Londinensis, 24 vols. 4to. 1810–29, by John Wilkes.
12. Brewster's Edinburgh Encyclopædia, 18 vols. 4to. 1810–30.
13. Pantologia, or New Dictionary of Arts and Sciences, 12 vols. 8vo. 1813–16. By Mason Good, Gregory, and Bosworth.
14. Burrowe's Modern Encyclopædia, 10 vols. 4to. 1816.
15. Encyclopædia Edinensis, 6 vols. 4to. 1816.
16. Encyclopædia Perthensis, 23 vols. roy. 8vo.; completed in 1816.
17. Encyclopædia Metropolitana, 1818.
18. Oxford Encyclopædia, 6 vols. 4to. 1824; supplement in 1 vol. 1831.
19. The London Encyclopædia, 24 vols. 8vo. 1826.
20. Partington's British Cyclopædia, 10 vols. 8vo. 1833–36.
21. Penny Cyclopædia, large 8vo. 1833–1843, 27 vols., and suppl. 2 vols.
22. Knight's English Encyclopædia, 22 vols. imp. 8vo. 1853–61.
23. Chambers's Encyclopædia (in course of publication).

France.

1. Dictionnaire Universel Français et Latin, known by the name Dictionnaire de Trévoux, 1704. 3 vols. fol. The fifth and last edition, Paris, 1771, 8 vols. fol.
2. Encyclopédie, ou Dictionnaire raisonné des Sciences, des Arts, et des Métiers, par Diderot et d'Alembert, 35 vols. fol. 1751–80. The original series 28 vols., 11 plates. A suppl. of 5 vols. was afterwards added, one of which consisted of plates; and a 'Table Analytique' 2 vols.
3. Encyclopédie, ou Dictionnaire Universel raisonné des Connaissances Humaines, par le Professeur de Felici. Yverdun, 1770–75. 42 vols. 4to.; and suppl. 6 vols. 4to.
4. Encyclopédie Méthodique, &c., 1782–1832, 201 vols. 4to., including 47 vols. of plates.
5. Dictionnaire des Sciences et des Arts, par Lumier, 3 vols. 8vo. 1805.
6. Encyclopédie Moderne, &c., par M. Courtin, 1823, &c. 24 vols. 8vo.
7. Encyclopédie des Dames, par une Société des Dames, Paris, 1821, &c.
8. Dictionnaire de la Conversation et de la Lecture. Paris, 1834–9, 52 vols. 8vo. or 104 livraisons.
9. Encyclopédie des Gens du Monde. Paris, 1833, &c. 22 vols. 8vo., completed in 1845.
10. Dictionnaire Général des Sciences théoriques et appliquées par Privat-Deschanel et Ad. Focillon; Paris, Masson et Fils (in course of publication).

Germany.

1. Grosse vollständige Universal Lexicon, von Zedler, 1732–50, 64 vols. 8vo.; with a suppl. Another edition was published 1751–54 in 4 vols. fol. Halle and Leipzig.
2. Deutsche Encyclopedie, &c., 1778–1804, by Koester and Roos. Of this work 23 vols. 4to. appeared, bringing it down to letter K.

3. Economische Encyclopedie, by Krunitz, Floerke, and Korte, 1774–1828. 148 vols. 8vo. Berlin.
4. Conversations-Lexicon, 1796–1809, 6 vols. 8vo.; besides a supplement of 2 vols. The 6th edition was completed at Leipzig, 1824, in 10 vols., with 2 of a supplement; since that time there have appeared several editions of this work, materially augmented. An English translation of it was completed at Philadelphia, in 13 vols. 8vo. 1820–33; republished at Glasgow in 6 vols.
5. Allgemeine Encyclopedie der Wissenschaften und Künste, von Ersch und Gruber, 1818, &c. Leipzig.
6. Gehler's Physicalisches Wörterbuch, neu bearbeitet von Brandes, Gmelin, Horner, Muncke, Pfaff, 9 vols. 8vo. Leipzig, 1825–40.
7. Haus-Lexicon, or Vollständiges Handbuch praktischer Lebens-kentnisse für alle Stände, 8 vols. 8vo. Leipzig, 1835–37.
8. Damen Conversations-Lexicon, 10 vols. small 8vo. Adorf, 1835–38.

Besides these, no fewer than twenty Encyclopædias of greater or less extent have been published in Germany; but, with the exception of the Conversations-Lexicon der Gegenwart, which forms a species of supplement to the Conversations-Lexicon above specified, they are not of such general importance as to be noticed here.

Italy.

1. Dizionario Scientifico e Curioso, Sacro, Profano, by G. P. Pinati. 10 vols. fol. Venice, 1746–51.
2. Encyclopedia Italiana. Naples, 1788.
3. Encyclopedia Methodica, Critica, Ragionnata delle belle Arti, by Pietro Zani. Parma, 1818–20.

America.

1. Encyclopedia Americana. A popular Dictionary of Arts, Sciences, Literature, History, Politics, and Biography. A new edition, including a copious collection of original articles in American biography, on the basis of the seventh edition of the German Conversations-Lexicon, edited by Francis Lieber, assisted by E. Wigglesworth. 14 vols. 8vo. cloth, edited by Henry Vethake, LL.D., Philadelphia, 1829–31. Vol. xiv., Philadelphia, 1846.
2. The New American Cyclopedia. Edited by George Ripley and Charles A. Dana. (Vol. I. A—Araguaya, royal 8vo. pp. 752 & xxvi. New York, 1858.)

But another branch of the same encyclopædian tree, which yielded such brilliant fruits in the hands of Ducange, Bayle, and Calmet, has taken deep root in Europe, and more especially in this country, and has greatly contributed to the diffusion of knowledge; viz. the compilation of Dictionaries appropriated to separate branches of literature, science or art. The grand object aimed at in such works, is to place within the reach of persons engaged in the business of active life a mass of well-digested, accurate, and readily accessible information upon subjects not connected with their own immediate pursuits, such as it might be exceedingly difficult for them to procure elsewhere; while even to the learned, or to those who have access and leisure to refer to more extensive depositories of human knowledge, they serve as convenient manuals or reference books.

Dictum (Lat. *something said*). A word used in common parlance to signify the arbitrament or award of a judge.

Dictyogens (Gr. δίκτυον, *a net*). A name proposed by Lindley for a subclass of plants previously associated with Endogens, distinguished by having net-veined instead of parallel-veined leaves. The class includes the *Dioscoreaceæ*, *Smilaceæ*, *Trilliaceæ*, *Roxburghiaceæ*, and *Philesiaceæ*.

Dictyophyllum (Gr. δίκτυον). A name given by Lindley and Hutton to a fossil leaf from the upper sandstone, shale, and coal of the Yorkshire oolite, and employed to designate all fossil leaves of a common reticulated structure; the term *phyllite* being applied to leaves whose principal veins converge both at the base and apex.

Didactic (Gr. διδακτικός, from διδάσκω, *I teach*). In the schools, this term signifies every species of writing, whether in verse or prose, the object of which is to teach or explain the rules or principles of any art or science. Thus, to this class of literature belong the writings of Aristotle on grammar, poetry, and rhetoric; Longinus's *Treatise on the Sublime*; the *Institutiones* of Quintilian, &c. But the term is more exclusively applied to all poetical writings devoted to the communication of instruction on a particular subject, or of a reflective or ethical character, thence called *didactic poetry*. Among the most celebrated poems of this species may be reckoned in ancient times that of Lucretius, *De Rerum Naturâ*, in which the Epicurean system of philosophy is explained; Virgil's *Georgics*; and Horace's *Art of Poetry*; in more recent times, Pope's *Essay on Criticism* and *Essay on Man*; Du Fresnoy's *Art of Painting* (see Mason's translation, in the Literary Works of Sir J. Reynolds); Vida and Boileau's *Art of Poetry*; Akenside's *Pleasures of the Imagination*; Armstrong's *Art of Preserving Health*; Somerville's *Chace*; Dyer's *Fleece*; Young's *Universal Passion*, &c.

Didactyle (Gr. διδάκτυλος, *two-fingered*). This epithet is applied to various animals, as to the ruminants among quadrupeds (by Klein); to the ostrich among birds; to the amphiuma, an amphibious reptile with two digits on each extremity; and to certain insects, as the *Pterophorus didactylus* and *Gryllotalpa didactyla*.

Didelphys (Gr. δίς, and δελφύς, *womb*). A generic name originally applied to the opossum, and all other quadrupeds which like it have a duplicature of the integument of the abdomen forming a pouch, in which the young are received, protected, and nourished, as in a second womb, until their growth is advanced

to a stage corresponding to that of the new-born young in the ordinary mammalia. In modern systems the term is, singularly enough, restricted to that group of Marsupials in which there are certain species deficient in the abdominal pouch. The genus *Didelphys*, or true opossums, are characterised by the following dental formula: incisores $\frac{10}{8}$, canini $\frac{2}{2}$, molares spurii $\frac{6}{6}$, molares veri $\frac{8}{8}$, $= 50$; and by having the hinder foot provided with a thumb, and a prehensile tail.

Didus. The generic name for the dodo or dronte. Birds of this kind were discovered by the Portuguese in 1499 on the island now called Mauritius, where they were afterwards observed by the Dutch in 1598, and in the early part of the following century. Original figures of the bird are given in *De Bry* (*Quinta pars Indiæ Orientalis*, &c. 1601); by Clusius, in his *Exotica*, 1605; by Herbert, in his *Travels*, 1634; by Bontius (Piso's edition, 1658); and by Savery, in his celebrated picture of 'Orpheus charming the Beasts,' now in the museum at the Hague. The last figure is the best; it was painted, as were the other figures of exotic species in the same picture, from studies of the living animals preserved at that time in the managerie of Prince Maurice of Nassau. It is highly probable that the same dodo was the subject of the painting of which the one now in the British Museum is a copy.

Besides this pictorial evidence there exist a head and a foot of the dodo in the Ashmolean Museum at Oxford, and a foot of the dodo in the British Museum. The following is Willoughby's translation of the original description of this extinct bird by Clusius: 'The dodo is called by Clusius, *Gallus gallinaceus peregrinus*; by Nieremberg, *Cygnus cucullatus*; by Bontius, *Dronte*. This exotic bird, found by the Hollanders in the island called by the Portuguese *Cygnæa* or *Cerne*, that is the Swan Island, and Mauritius Island by the Low Dutch, of thirty miles' compass, famous especially for black ebony, did not exceed a swan in bigness; but was of a far different shape, for its head was great, covered as it were with a certain membrane resembling a hood; besides, its bill was not flat and broad, but thick and long, of a yellowish colour next the head, the point being black. The upper chap was hooked; the nether had a bluish spot in the middle, between the yellow and black part. They reported that it is covered with thin and short feathers, and wants wings, instead whereof it hath only four or five long black feathers; that the hinder part of the body is very fat and fleshy, wherein for the tail were four or five small curled feathers, twirled up together, of an ash colour. Its legs are thick rather than long, whose upper part, as far as the knee, is covered with black feathers; the lower part, together with the feet, of a yellowish colour; its feet divided into four toes, three (and those the longer) standing forward, the fourth and shortest backward, all furnished with black claws. After I had composed and writ down the history of this bird, with as much diligence and faithfulness as I could, I happened to see in the house of Peter Pauwius, primary professor of physic in the university of Leyden, a leg thereof cut off at the knee, lately brought over out of Mauritius his island. It was not very long from the knee to the bending of the foot, being but little more than four inches, but of a great thickness; so that it was almost four inches in compass, and covered with thick-set scales; on the upper side broader, and of a yellowish colour; on the under (or back side of the leg) lesser and dusky. The upper side of the toes was also covered with broad scales; the under side wholly callous. The toes were short for so thick a leg; for the length of the greatest or middlemost toe to the nail did not much exceed two inches; that of the other toe next to it, scarce came up to two inches; the back toe fell something short of an inch and a half; but the claws of all were thick, hard, black, less than an inch long; but that of the back toe longer than the rest, exceeding an inch. The mariners in their dialect gave this bird the name *Walgh-vogel*, that is, a nauseous or yellow bird; partly because after long boiling the flesh became not tender, but continued hard, and of difficult concoction (excepting the breast and gizzard, which they found to be of no bad relish), partly because they could get many turtle-doves, which were much more delicate and pleasant to the palate. Wherefore it was no wonder that in comparison of those they despised this, and said they could be well content without it. Moreover they said that they found certain stones in its gizzard; and no wonder, for all other birds, as well as these, swallow stones to assist them in grinding their meat.' Thus far Clusius.

Now with respect to the parts of the bird which still remain to us, we infer that the head (from the sudden rising of the cranium above the face, and the form of the anterior extremity of the lower jaw, as also from the nostrils being covered with an arched scale) did not belong to a vulture or any other Accipitrine bird; while in the presence of the cere at the base, and the forward position of the nostrils, it resembles the rhea and apteryx among the Struthious birds. The apteryx, however, deviates more from the typical *Struthionidæ* in the shape of the bill and position of the nostrils than does the dodo. With respect to the foot in the British Museum, this differs from that of the vulture in the form and disposition of the tarsal scales, in the shortness of the middle toe, and the bluntness and straighter figure of the claws; while in all these respects it agrees with the foot of the apteryx and the Gallinaceous order. Hence, even those naturalists who still reject the evidence in proof of the Struthious nature of the dodo, and deny its existence at any period, are compelled to imagine that the bird represented in the original figures above quoted was made up by joining the head of a bird of prey

to the legs of a Gallinaceous bird. The analogies of ornithology, however, by no means sanction the rejection of the multiplied, and, if we accept Leguat's narrations, consistent, evidence of the actual existence of the Struthious dodo. Whoever inspects the painting by Savery, above mentioned (which seems hitherto to have escaped the attention of the naturalists who have written on the dodo), must feel a conviction that its original was no factitious or artificial specimen. Neither the head nor the feet still preserved in our museums can be referred to an albatross, a penguin, a vulture, or any other known existing species; while they closely correspond (allowing for the absence of the horny sheath of the bill) with the original figures of the dodo. We have therefore no hesitation in concluding that in other respects those figures are equally faithful representations of the extinct Struthious form in question. Such also appears to be the conclusion to which the learned writer of the article 'Dodo' in the *Penny Cyclopædia* arrived: 'If the picture in the British Museum and the cut in Bontius be faithful representations of the creature then living, to make such a bird a bird of prey, a vulture in the ordinary acceptation of the term, would be to set all the usual laws of adaptation at defiance. A vulture without wings! How was it to be fed? And not only without wings, but necessarily slow and heavy in progression on its clumsy feet. The *Vulturidæ* are, as we know, among the most active agents in removing the rapidly decomposing animal remains in tropical and intertropical climates; and they are provided with a prodigal developement of wing to waft them speedily to the spot tainted by the corrupt encumbrance. But no such powers of wing would be required by a bird appointed to clear away the decaying and decomposing masses of luxuriant tropical vegetation—a kind of vulture, for vegetable impurities, so to speak; and such an office would not be by any means inconsistent with comparative slowness of pedestrian motion.'

Mr. Hugh Strickland, in his work *The Dodo and its Kindred*, advocated the theory that this bird belonged to the group *Columbidæ*, and that it was, in fact, a gigantic pigeon, allied to the *Didunculus* which is found in the Samoan Islands in the Pacific Ocean. Dr. Melvill supported this conclusion by the comparison of the osteological evidences preserved to us with those of existing Columbidæ. In 1851, Mr. Bartlett, the taxidermist, prepared an ideal model of the dodo, based on the pictorial evidences, which was exhibited at the International Exhibition. The strenuous exertions of future travellers near the Mauritius may, by the discovery of osteological proofs, afford a more conclusive demonstration of this remarkable extinct bird.

Didymium (Gr. δίδυμος, *twin*). A metallic element associated with cerium in the mineral cerite. Its salts are mostly of a red colour; but didymium itself has not been isolated.

Didymous. In Botany, growing in pairs, like the fruit of Umbelliferous plants.

Didynamous (Gr. δίς, and δύναμις, *power*). A term applied to flowers having four stamens, of which two are short and two are long.

Die (Fr. dé). In Coinage, is the instrument by which the impressions are given upon the various denominations of coin. The following is an outline of the *die manufacture*, as conducted in her majesty's Mint: The engraver selects a forged plug of the best cast steel of proper dimensions for his intended work; and having carefully annealed it, and turned its surfaces smooth in the lathe, proceeds to engrave upon it the intended device for the coin; the Queen's head, for instance. When this is perfect, the letters are put in, and the circularity and size duly adjusted; it is then hardened, and is termed a *matrix*. Another plug of soft steel is now selected; and the matrix being carefully adjusted upon it, they are placed under a very powerful fly-press, and two or three blows so directed as to commence an impression of the matrix upon the plug; this is then annealed, and the operation repeated till the plug receives a perfect impression of the work upon the matrix. This impression is of course in *relief*, the original work upon the matrix being indented, and produces what is termed the *punch*. This, being duly shaped in the lathe, is hardened, and is employed in the production of impressions in soft steel, or *dies*, which being properly turned and hardened, are exact *fac-similes* of the original matrix, and are used in the process of *coinage*. When a pair of dies are made of good steel duly hardened and tempered, and are carefully used, they will sometimes yield from two to three hundred thousand impressions before they become so far worn or injured as to require to be removed from the coining presses.

Dieffenbachia (named after M. Dieffenbach). A genus of *Araceæ* belonging to the tropics of the New World, and consisting of herbs having tall fleshy stems, rather large leaves often variegated, and spadices enclosed in yellowish spathes. The female flowers are confined to the base of the spadix. *D. seguina* is the Dumb Cane of the West Indies, a virulent plant, whose juice is so acrid as to render speechless for days those who may happen to bite the stems, which, when the leaves are gone and the ring-like markings become evident, bear some resemblance to those of the Sugar Cane.

Dielectric. A body which admits of the force of electricity acting through it.

Diercsilis. A term invented by Mirbel to denote a many-celled superior fruit; the cells being dry, indehiscent, few-seeded, and cohering by a common style round a common axis, as in *Malva*.

Diesis (Gr.). In Music, an interval less than a comma. The harmonical diesis is the difference between a greater and a less semitone.

Diespiter. [Jupiter.]

Diet (Low Lat. dieta, from dies, *a day*; Ger. Reichstag). A name given to the principal national assembly in many countries of modern Europe.

By the usage of the *German Empire*, two diets were summoned every year by the emperor, besides such as were convoked on extraordinary occasions. There were three chambers—1. That of the electors [ELECTORS]. 2. That of the sovereign princes, divided into two spiritual and four temporal benches. The counts of the empire voted collectively in four benches or divisions, and not as individuals; the prelates and the abbots in two. 3. The chamber of the imperial cities, divided into the Rhenish and the Swabian benches. The diets, together with the emperor, exercised the prerogatives of sovereignty. A decree of the diet was termed a *recess of the empire*. The diet of the modern Germanic Confederation is a meeting of plenipotentiaries, permanently assembled in the city of Frankfort-on-the-Maine. [CONFEDERATION.]

The diet of Hungary is, according to the constitution, composed of the king (emperor of Austria) and the estates. The latter consist of the higher clergy, the magnates, the two courts of appeal, and two representatives from each chapter, county, city, and privileged district. They are divided into two chambers called *tabulæ*.

The diet of Switzerland is composed of the representatives of the cantons, and manages such affairs as by the federal constitution are exempted from the jurisdiction of those several independent states. It is held every two years, alternately at Zurich, Berne, and Lucerne, which are termed the presiding cantons (vorort). The schultheiss or governor (chief executive magistrate) of the presiding canton is landamman of Switzerland for the time being. Each canton has one vote in the diet.

From a very remote period, down to 1832, Poland had national assemblies, or *diets*, which were of two sorts, *ordinary* and *extraordinary*. The ordinary diet was held every two years, and usually at Warsaw; though it was expressly enacted that every third meeting should be convened at Grodno, in Lithuania. The duration of its sitting was restricted to six weeks, and could not, under any pretext, be protracted beyond this period. The diet was composed of a selection from the nobility, who formed what was called the senate, and of the deputies returned by each of the palatinates and districts of the country. The number amounted to about 400. The period of its meeting was fixed by the king, who presided over its deliberations; except during an interregnum, when the business of summoning the diet devolved on the archbishop of Gnesna. The *extraordinary* diets differed from the *ordinary* chiefly in this, that there was no stated period for the former being summoned together, that they were convoked only to listen to propositions from the throne, and lasted only four days.

As is well known, the throne of Poland was not hereditary, but elective; and, on the occasion of choosing the sovereign, the Polish diets were held in the open country, and were attended by all the nobility on horseback, armed and equipped as if for battle. On this subject the reader is referred to a work of great ability, by De la Birardière, entitled *Histoires des Diètes de Pologne, pour les Élections des Rois, depuis* 1572 *jusqu'en* 1674 (8vo. Paris 1679). *Dietines* was the name given to the particular assemblies of the Polish nobility in which deputies were elected to serve in the ordinary diets, and to represent the wishes and interests of their constituents. In these dietines every gentleman possessing an estate of three acres had the right of voting, and every deputy was chosen by the majority of suffrages.

Diet Drink. Alterative decoctions taken in considerable quantities; such as decoction of sarsaparilla, sassafras, dandelion, &c. *Lisbon diet drink* nearly resembles the compound decoction of sarsaparilla of the London Pharmacopœia.

Dietetics (Gr. διαιτητικός). That part of medical science which relates to the diet or ordinary food. [DIGESTION and FOOD.]

Diethylamine. A compound which may be represented as ammonia, two atoms of whose hydrogen have been replaced by two of ethyl. It is a colourless volatile inflammable caustic liquid.

Diethylin. A colourless liquid derived from two atoms of alcohol and one of glycerin.

Dieu et Mon Droit (Fr. *God and my right*). The motto of the royal family of England. It was first assumed by Richard I., to intimate that he held his sovereignty from God alone, and not in vassalage to man; and it would seem that it fell into desuetude among the immediate successors of that prince, and remained so till the reign of Edward III., by whom it was revived when he first claimed the crown of France. Since that period, if we except the reigns of Elizabeth, William III., and Anne, the first and last of whom used the motto, *Semper eadem*, and the second, though only in his private capacity, *Je maintiendrai*, *Dieu et mon droit* has always formed the royal motto of England.

Diffarreatio (Lat.). The Roman ceremony for dissolving marriages contracted by *confarreatio*. Such marriages could be made only by patricians, and the confarreation was a religious ceremony in which *panis farreus*, or corn bread, was employed in the presence of ten witnesses, and certain words were spoken, which brought the woman *in manum viri*, or under the authority of her husband.

Difference (Lat. differentia). In Arithmetic and Algebra, the excess of one quantity over another, or the result of the operation of subtraction.

DIFFERENCE. In Logic, one of the predicables. It is that particular quality which distinguishes the subject from all others, when

contemplated from that point of view in which we are then regarding it; and is said, logically, to be part of the essence of the subject. The genus, together with the difference, is said to make up the species; the species, with the difference, to make up the lower species, or the individual: e.g. To the genus metal add the difference 'susceptible of magnetic attraction,' and we obtain the species iron, which is distinguished from all other metals by that peculiarity.

Differences. In Heraldry, devices borne on the escutcheon to indicate the part of a family to which the bearer belongs. This has been effected by various methods—at present by what are termed *brisures, marks of filiation*, or of *cadency*; being small charges placed conspicuously in the shield. The eldest son bears a label of three points; the second, a crescent; the third, a mullet; the fourth, a martlet; the fifth, an amulet or small ring; the sixth, a fleur-de-lys; the seventh, a rose; the eighth, a cross moline; the ninth, a double quatrefoil. The family of the second son repeat these differences on their own paternal mark of filiation: e.g. the second son's first son bears a crescent ensigned with a label, and so on of the rest. Females do not bear differences.

Differences, Calculus of. The science whose object is the investigation of the ratios which exist between the simultaneous increments or changes of mutually dependent quantities. It is distinguished from the differential calculus by the circumstance that in the latter the *limits* of these ratios alone enter into consideration. If u_x denote any function of x, say the x^{th} or general term of a series, then the difference $u_{x+1} - u_x$ is denoted by the symbol Δu_x, and Δ is the symbol of the fundamental operation in the calculus of differences, analogous to $\frac{d}{dx}$ in the differential calculus. The former indeed corresponds to $\frac{\Delta}{\Delta x}$, the constant difference Δx being supposed equal to 1, as, without loss of generality, it always may be. The *first difference* Δu_x being itself a function of x, the operation Δ can of course be repeated upon it; the result is called the *second difference*, and is denoted by $\Delta \Delta u_x$ or $\Delta^2 u_x$. In the same way we proceed to differences of higher orders, the symbols of the corresponding operations being subject to the ordinary index-law $\Delta^m \Delta^n = \Delta^{m+n}$. The symbol Δ is also distributive, that is to say, $\Delta(u_x + v_x) = \Delta u_x + \Delta v_x$, and it enters into combination with constant magnitudes just as a symbol of quantity would do, since it possesses the commutative property $\Delta a u_x = a \Delta u_x$. The *succeeding value* to u_x is often denoted by $D u_x$, and since

$$D u_x = u_{x+1} = u_x + \Delta u_x,$$

we see that the operative symbol D is connected with Δ by means of the relation $D = \Delta + 1$, and consequently possesses the same three characteristic properties. On the other hand, by Taylor's theorem, in its symbolical form, we have $D = e^{\frac{d}{dx}}$. The operations D, Δ and $\frac{d}{dx}$ are convertible one into the other by means of these remarkable and important relations. For instance, by the first relation we have at once

$$u_{x+n} = D^n u = (1 + \Delta)^n u_x,$$

$$= u_x + n \Delta u_x + \frac{n(n-1)}{1 \cdot 2} \Delta^2 u_x + \&c. \ldots,$$

a formula by which the n^{th} succeeding value u_{x+n} is expressed in terms of u_x, and its first n successive differences. Conversely

$$\Delta^n u_x = (D-1)^n u_x$$

$$= \left(D^n - n D^{n-1} + \frac{n(n-1)}{1 \cdot 2} D^{n-2} . + (-1)^n\right) u_x$$

$$= u_{x+n} - n u_{x+n-1} + \frac{n(n-1)}{1 \cdot 2} u_{x+n-2} . \&c. \ldots$$

$$\ldots . + (-1)^n u_x,$$

an important formula, by means of which differences of any order can be calculated when a series of successive values is known.

The differences hitherto considered have been *total* ones, the subject u_x being a function of a single variable x. With functions of two or more variables arise *partial differences*, by which term is to be understood the differences formed on the hypothesis that one only of the variables suffers a change of value. Of English works on the calculus of differences, we may mention De Morgan's *Differential and Integral Calculus*, and Sir J. Herschel's appendix to the English translation of *Lacroix*, as well worthy of careful study; but Boole's *Treatise on the Calculus of Finite Differences*, London 1860, contains the most recent and complete exposition of its principles and methods.

Differences, Equation of. [Equation of Differences.]

Differences of Zero. Important numbers which frequently occur in the theory of series and in the calculus of differences. Their origin may be understood by considering the series of x, numbers $0^m, 1^m, 2^m, 3^m$, &c. If under each of these terms the difference between it and the succeeding term is written, a series of *first differences* will be obtained, and from the terms of this series, a series of *second differences* may be deduced in a similar manner, and so on; the terms of the series of m^{th} differences will all be equal, so that there will be no series of $(m+1)^{th}$ differences. A table being thus formed, the numbers under 0^m, in the first column, will be the *differences of zero* corresponding to the index m; they are usually represented by the symbols $\Delta 0^m, \Delta^2 0^m, \Delta^3 0^m \ldots \Delta^m 0^m$, the last of which has the value $1 . 2 . 3 \ldots m$.

In general

$$\Delta^n x^m = (x+n)^m - n(x+n-1)^m$$

$$+ \frac{n(n-1)}{1 \cdot 2}(x+n-2)^m \&c.$$

[Differences, Calculus of]; so that, putting

$$x=0\ \Delta^n 0^m = n^m - n(n-1)^m + \frac{n(n-1)}{1\cdot 2}(n-2)^m \ldots + (-1)^{n-1} n\, 1^m.$$

Differential Calculus. The name by which one of the most important branches of the higher mathematics is usually designated, and in which magnitudes are contemplated as susceptible of *continuous* growth.

The most important of the terms which are employed in the calculus will be elsewhere explained; moreover, as there are numerous treatises on the subject, a few general remarks, relative to its nature and history, will here suffice. Broadly speaking, the object of the differential calculus may be said to be the determination of the ratios of the differences of mutually dependent variable magnitudes, on the supposition that these differences become *infinitely small*; an hypothesis which gives rise to considerable abbreviations in the general calculation of differences.

The infinitely small variation, increment or decrement, of a quantity is termed its *differential*, and is expressed by writing the letter d before the magnitude or function: thus dx signifies the differential of the variable magnitude x, $d(xy)$ the differential of the product of the two variables x and y, and so on. The differential of a differential is called the *second differential*, and, x being the variable, is denoted by ddx, or more briefly by d^2x. In a similar manner d^nx is the n^{th} differential of x. The letter d was introduced by Leibnitz, and is now adopted by all writers as the symbol of differentiation.

The differential calculus, although invented by Leibnitz, was reduced to a systematic form, and greatly extended, by the two celebrated brothers James and John Bernoulli. Some years, however, before Leibnitz fell on the discovery, the method of *fluxions*, with which the differential calculus agrees in every respect, excepting its notation and the manner in which the principles are usually explained, had been invented and applied by Newton. This circumstance gave rise to a dispute, which was long carried on with great acrimony, between the mathematicians of England on the one hand, who put forward the claims of Newton for the honour of the invention, and those of France and Germany on the other, who gave the merit of it to Leibnitz. It was established beyond doubt that Newton was in possession of his method before it had been thought of by Leibnitz: the only question, therefore, was whether Leibnitz received such hints or information respecting the nature of Newton's method as were sufficient to guide him to its discovery. Of this there is no evidence, and extremely little probability; accordingly, mathematicians have long agreed to recognise the claims of Leibnitz as an independent inventor. It was only at the commencement of the present century that the notation $\dot{x}$, introduced by Newton for the fluxion (differential) of x, was finally replaced by the more convenient notation of Leibnitz and the Bernoullis.

Differential Coefficient. The limit of the ratio which the increment of a function bears to that of its independent variable, when the latter is conceived to diminish indefinitely. Thus $y=\text{F}(x)$ being the function, and Δx an increment of x, the limit to which the ratio

$$\frac{\text{F}(x+\Delta x)-\text{F}(x)}{\Delta x}$$

approaches as Δx diminishes is the differential coefficient of y, and is denoted by the symbol $\frac{dy}{dx}$, which latter, accordingly, must not be regarded as an ordinary fraction, but as the symbolised result of the complex operation, above defined, upon the given subject y. This operation is the fundamental one of the differential calculus, and is itself denoted by the symbol $\frac{d}{dx}$; the result is, in general, another function of x, in fact the *derived function* $y'=\text{F}'(x)$, and may be operated upon in the same manner a second time. Two such successive operations are denoted by the symbol

$$\frac{d}{dx}\,\frac{d}{dx}\ \text{or}\ \frac{d^2}{dx^2},$$

and the result $\frac{d^2y}{dx^2}$ is termed the *second differential coefficient* of y. It is important to observe that the operative symbol $\frac{d}{dx}$ not only obeys the ordinary *index law*, expressed by

$$\frac{d^m}{dx^m}\,\frac{d^n}{dx^n}=\frac{d^{m+n}}{dx^{m+n}},$$

but is also *distributive*, that is to say,

$$\frac{d}{dx}(u+v)=\frac{du}{dx}+\frac{dv}{dx};$$

it is, moreover, *commutative* with respect to symbols of *constant* or invariable quantities; thus

$$\frac{d}{dx}(au)=a\,\frac{du}{dx}.$$

Hence it follows that the operative symbol $\frac{d}{dx}$ combines, precisely as a quantitative one would do, with other symbols of constant quantities. Thus the operation

$$\frac{d^2}{dx^2}+2\frac{d}{dx}-3,$$

performed on any function of x, is equivalent to the operations

$$\left(\frac{d}{dx}-1\right)\ \text{and}\ \left(\frac{d}{dx}+3\right)$$

performed successively. Important applications and extensions of this principle are made in the differential calculus. [LINEAR.]

The differential coefficient of a function z of two or more variables x, y, &c., formed on the hypothesis that one only, x, of the latter changes its value, is termed a *partial differential coefficient* of z according to x, and is represented

by the symbol $\left(\frac{dz}{dx}\right)$ or simply by $\frac{dz}{dx}$ when more precise definition is not needed. The partial differential of $\frac{dz}{dx}$ taken with respect to the variable y is of course represented either by

$$\frac{d^2z}{dy\,dx} \text{ or } \frac{d^2z}{dx\,dy},$$

and so on.

Differential Equation. A relation connecting the differentials or differential coefficients of variable functions with each other, and with the functions themselves. The object contemplated in the study of such equations is, usually, to discover the most general relation between the primitive variables, which by differentiation would lead to the differential equation under consideration. This general relation is called the *complete primitive*, when the direct operations are contemplated, which, when performed upon it, lead to the differential equation, and the *complete solution* or *final integral* when the inverse procedure corresponds to the order of thought. Differential equations are divided into two great classes, *ordinary* and *partial*; the first have reference to a single independent variable, whilst the latter involve partial differential coefficients, and indicate, consequently, the existence of two or more independent variables. Differential equations of both kinds are further distinguished by their *order* and *degree*, which terms are no longer synonymous as in algebra. The *order* of a differential equation is the same as that of the highest differential coefficient it contains, whilst its *degree* coincides with the highest power to which this differential coefficient of highest order is raised, when the equation is reduced to a rational form. Certain special forms of differential equations have received distinctive names. Amongst these may be mentioned *exact* differential equations, which are obtainable immediately by the differentiation of some function which has a constant value; and *homogeneous* differential equations, which are characterised by the homogeneity either of the several terms or of certain factors of these terms. The term *linear*, as applied to differential equations in two variables, does not mean, precisely, *of the first degree*; it denotes merely that the equation is of the first degree in the dependent variable and its differential coefficients. Thus, if X, X_1, X_2, &c. denote functions of x solely, the equation

$$\frac{d^n y}{dx^n} + X_1\frac{d^{n-1}y}{dx^{n-1}} + \ldots . X_n y = X$$

would be called *linear*.

When from a primitive equation connecting x and y with n arbitrary constants, r other equations are derived by successive differentiation, the elimination of any r of the n constants from the system of $r+1$ equations thus obtained, will lead to a differential equation of the r^{th} order containing $n-r$ constants. By selecting all possible groups of r constants for elimination, it will clearly be possible to form

$$\frac{n\,(n-1)\,.\,.\,(n-r+1)}{1\cdot 2\,.\,.\,.\,r}$$

such equations, but of this number only $r+1$ will be independent. There will further be one and only one differential equation of the n^{th} order, free from arbitrary constants. Conversely, an ordinary differential equation of the n^{th} order in two variables implies the existence of n independent *first integrals* or differential equations of the $(n-1)^{\text{th}}$ order, each containing an arbitrary constant, and of one final integral involving n arbitrary constants.

Partial differential equations may arise either from the elimination of arbitrary functions or of arbitrary constants from a primitive relation between the variables. In the former case this relation is called the *general*, in the latter the *complete* primitive. There does not exist, however, the same relation, as in ordinary differential equations, between the order of a partial differential equation and the number of arbitrary functions in its general primitive. For instance, it is not always possible from a general primitive, involving two arbitrary functions of x, y, z, to obtain a partial differential equation of the second order free from arbitrary functional symbols.

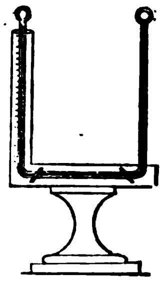
The methods of solving the most important and frequently occurring forms of differential equations are given in all good treatises on the calculus. Of the works specially devoted to the subject, the most recent one is that by Prof. Boole (London 1859), which contains valuable chapters on the application of symbolical methods. Prof. Cayley's Reports on the Recent Progress of Theoretical Dynamics may be mentioned, too, as containing very valuable information on the higher branches of the subject; they will be found in the *Proceedings of the British Association*, 1857–63.

Differential Resolvent. An algebraic equation, of the n^{th} degree, being given, whose coefficients are functions of a single parameter, its *differential resolvent* is a certain linear differential equation of the $(n-1)^{\text{th}}$ order which is satisfied by each of the roots of that equation. Messrs. Cockle and Harley were the first to investigate the properties of the differential resolvent; their researches will be found in *Phil. Mag.* 1862, and *Quart. Jour. Math.* 1862–3. Prof. Boole's last contribution to the *Phil. Trans.* (1865) was on this subject.

Differential Galvanometer. [GALVANOMETER.]

Differential Thermometer. An ingenious instrument, of great use in experimental philosophy, for measuring very small differences of temperature; invented and first applied by Sir John Leslie, though the idea of an instrument of the same kind seems to have long before suggested itself to Sturmius. The differential thermometer is described by Leslie, in his *Experimental Inquiry into the Nature and Pro-*

pagation of Heat, nearly as follows: Two glass tubes of unequal lengths, each terminating in a hollow ball, and having their bores somewhat widened at the other ends, a small portion of sulphuric acid tinged with carmine being introduced into the ball of the longer tube, are joined together by the flame of a blow-pipe, and afterwards bent into nearly the shape of the letter U; the one flexure being made just below the joining, where the small cavity facilitates the adjustment of the instrument, which, by a little dexterity, is performed by forcing with the heat of the hand a few minute globules of air from the one ball into the other. The balls are blown as equal as the eye can judge, and from four-tenths to seven-tenths of an inch in diameter. To one of the legs of the thermometer a scale is attached; and the liquid contained in the tube is so disposed that it stands in the graduated leg opposite the zero of the scale, when both balls are exposed to the same temperature. From this construction of the instrument, it is easy to see that it is affected by the difference only of heat in the two balls. As long as both balls are of the same temperature, whatever this may be, the air contained in the one will have the same elasticity as that contained in the other; and consequently the intercluded coloured liquid, being thus pressed equally in opposite directions, must remain stationary. But if, for instance, the ball which holds a portion of the liquor be warmer than the other, the superior elasticity of the confined air will drive it forwards, and make it rise in the opposite branch above the zero, to an elevation proportional to the excess of elasticity or of heat. Sulphuric acid is chosen as the liquor best adapted to the purpose; because it is not vaporisable, and consequently does not by its vapour affect the pressure of the air above it. The carmine is used to render it more easily visible.



Differentiation. In Mathematics, the operation by which the differential of a function is determined, and of which d is the symbol. The allied operation which leads to the determination of the derived function or *differential coefficient*, and which is symbolised by $\frac{d}{dx}$, is usually termed *derivation*. By the *partial* differentiation of a function of two or more independent variables, is understood the differentiation of that function on the hypothesis that one only of these variables suffers a change of value. [DIFFERENTIAL COEFFICIENT.]

Finite differentiation, again, denotes the operation by which the *difference* of a function, corresponding to a finite difference of the variable, is determined. The latter difference being unity, the symbol of finite differentiation is Δ. [DIFFERENCES, CALCULUS OF.]

Diffluan. A term applied to a substance formed by long boiling a solution of alloxanic acid. It is represented as $C_6\ H_8\ O_8\ N_4$.

Diffraction (Lat. dis, and frango, *I break*). In Optics, a species of deviation or deflection which the rays of light undergo in passing very near to any opaque body. This phenomenon was first observed by Grimaldi, who described the principal appearances with sufficient accuracy; but Newton first attempted to explain its cause by the general properties of light. His experiments are detailed in the last book of his *Optics*. In order to exhibit the phenomena of diffraction, let a beam of solar light, reflected horizontally, be admitted into a dark chamber through a small round hole, and received on a white vertical wall. If the hole have a sensible diameter, the image of the sun thrown on the wall will suffer no sensible alteration of colour; but if we place in the axis of the beam of light, and at a distance of five or six feet from the hole through which it is admitted, a metallic plate, having a puncture made in it by the point of a very fine needle, and intercepting all other light than that which passes through the puncture, the appearance on the wall will no longer be a circular spot of white light only; it will be surrounded with several concentric coloured rings, covering a space far exceeding in extent that which the solar beam would have occupied if the rays of which it was composed had followed their rectilinear direction. By substituting a very narrow slit for the puncture in the metallic plate, or several punctures or slits very close to each other, and arranged in a certain manner, some of the most beautiful phenomena of optics are exhibited.

Diffusion of Gases. When two gaseous bodies which do not act chemically upon each other are mixed together in any relative proportions, they gradually diffuse themselves through each other; so that after a sufficient time has elapsed for the purpose, whatever may have been their relative densities, they are found intimately blended: the heavier gas does not fall, nor does the lighter one float. Dalton, therefore, has appropriately represented gaseous bodies as acting as *vacua* to each other. Professor Graham's researches have lately thrown much new light upon this subject, and he has determined the laws of *gaseous diffusion* by a series of well-conceived experiments. (Graham's *Elements of Chemistry*, vol. i. p. 71.) [GASES, DIFFUSION OF.]

Digamma (Gr. *double gamma*, Γ, so called from its representing two gammas, thus, The name given to the form of that letter in the ancient Greek alphabet which corresponds in appearance generally to the Latin F. This letter appears to have occupied the sixth place in the alphabet, and was most prevalent in the Æolic dialect, though some grammarians contend that it was common to all the dialects of Greece in their more ancient mode of pronun-

ciation. As the Latin language approximated more nearly to the Æolic than to any of the other Grecian dialects, the use of the digamma is very prevalent in many Latin words, and the facility with which it was there interchanged for V, both at the commencement and in the middle of words, will be at once apparent from the following examples: Gr. ἔαρ, *spring*, Æol. Fέαρ, Lat. ver; Gr. ἕσπερος, *evening*, Æol. Fέσπερος, Lat. vesperus; Gr. οἶνος, *wine*, Æol. Fοῖνος, Lat. vinum. It must not, however, be supposed that the digamma is to be regarded as simply synonymous with the labial semi-vowel *v*. It represents at least three different letters in the cognate languages, namely, *v*, *s*, *y*. (Grote's *History of Greece*, part i. ch. xxi.)

Digastric Muscle (Gr. δίς, and γαστήρ, *belly*). A double muscle, situated externally between the lower jaw and mastoid process; it is attached to the *os hyoides* in the human subject at the middle of its course. It pulls the lower jaw downwards and backwards; and when the jaws are shut, it draws the larynx, and with it the pharynx, upwards in the act of swallowing.

Digenesis (Gr. δίς, and γένεσις, *birth*). Professor van Beneden applies this term to the generation of those *Entozoa* in which intermediate forms are interpolated alternately. Professor A. Thomson applies it to origin from two parents, each concerned in the reproductive act.

Digest (Lat. digestus, *brought into order*). Several compilations of the Roman Law have been so called; but the best known is that which was made by order of the emperor Justinian. It is also termed the Pandects, from the Greek words, πᾶν, *all*, and δέχεσθαι, *to receive*; signifying the general nature of the collection. The care of this great compilation was intrusted by the emperor to Tribonian, with seventeen associates. It was completed in three years, and published A.D. 533. It contains the best decisions and opinions of former jurists, collected, it is said, from more than 2,000 volumes; and follows the same arrangement as the code of the same emperor, which had appeared in 529. The Pandects of Justinian, according to the commonly received story, were neglected in the Eastern Empire shortly after the decease of that emperor, and were wholly lost in the West until the accidental discovery of a MS. at Amalfi in 1130. But this tradition is now generally believed to rest on no solid foundation. [LAW, CIVIL.] (Gibbon, cap. xliv.; Savigny *On the Roman Law*.)

Digester. A strong iron or copper vessel with a tightly adjusted lid, furnished with a safety valve, in which bodies may be subjected to the action of high-pressure steam, or of water above its ordinary boiling temperature. It is known as *Papin's Digester*.

Digestion (Lat. digestio). The general process by which food is converted into *chyme* in the stomachs of animals, and by which it is rendered fit for the production of *chyle*, and ultimately of *blood*. The term *digestion* is also more generally applied to the entire functions of the intestinal canal. The phenomena of digestion, though exclusively chemical, are also under the immediate influence of vitality, and are consequently perfectly different from any changes which the food suffers out of the body; hence the unsatisfactory conclusions of the older physiologists, who considered attrition, fermentation, and similar mechanical and chemical processes as sufficient to account for the extraordinary changes that are produced. It has been clearly ascertained that the influence of the nervous system is essential to the due performance of the functions of the stomach; and that when the brain, or the nerves that supply that viscus, are either injured or divided, digestion is either impaired or altogether suspended, and the food then ferments and putrefies instead of digesting. It has been said that the transmission of a current of electricity through the nerves is equivalent to their connection with the brain, and that under such circumstances the stomach, notwithstanding the division of its nerves, continues its functions; but these, and other statements in which electricity is said to be equivalent to the nervous and cerebral agency, require much more extended experimental proofs than they have hitherto received, before they can be admitted as true interpretations. It may, however, be concluded that nerve force, though not identical with electric force, may be another mode of action of the same common force.

DIGESTION. In Surgery, this term was formerly applied to the treatment by which wounds or ulcers were brought into that state in which they form healthy pus: the remedies or applications promoting this object were termed *digestives*.

Digit (Lat. digitus, *finger*). In Arithmetic, one of the ten symbols, 0, 1, 2, 3, &c., by which all numbers are expressed. By astronomers the term is used, in speaking of eclipses, to denote the twelfth part of the diameter of the sun or moon. Thus, the eclipse is said to be of ten digits, if ten parts out of twelve of the diameter are concealed.

Digitalia. A very poisonous vegetable alkaloid, procured from the leaves of the *digitalis*.

Digitalis (Lat.). This genus of *Scrophulariaceæ* is represented by the well-known Foxglove, *D. purpurea*, one of the finest of our native plants, found in woods and by roadsides. The plant has a tuft of large ovate oblong root-leaves, from among which rise the erect flower-stems, bearing a long one-sided raceme of drooping irregularly bell-shaped flowers of a rich pinkish-purple, paler inside, and marked there with dark spots. The Foxglove possesses powerful medicinal properties, due to the presence of an extremely poisonous principle, called *digitalia*. It is used in dropsy and heart disease, but requires great caution in its administration. It diminishes the fullness and frequency of the pulse, and increases the flow of urine. In cases of poisoning

by this plant, the stomach-pump, or emetics, should be resorted to, while ammonia and similar stimulants should be given to prevent fainting.

Digitate (Lat. digitatus, *having fingers*). In Botany, the term used when several distinct leaflets radiate from the end of a leaf-stalk, as in the Horse-chestnut.

Digitigrades, Digitigrada (Lat. digitus, and gradior, *I walk*). The carnivorous quadrupeds which walk on the extremities of their digits. An artificial group of *Carnivora* is so called in the system of Cuvier.

Diglyph (Gr. δίγλυφος, *doubly indented*). In Architecture, a projecting face with two panels sunk thereon, sometimes introduced on the entablature of the Doric order instead of the triglyphs.

Dignitary. In the Canon Law, this term signified originally a person who held an ecclesiastical benefice or dignity, which gave him some preeminence above ordinary priests. To this class exclusively belonged all bishops, deans, archdeacons, &c.; but it now includes also prebendaries and canons.

Digression (Lat. digressio, *a stepping aside*). In Astronomy, the apparent distance of the inferior planets Mercury and Venus from the sun. Mercury is never seen at a greater distance than about 28° from the sun; this is called its *greatest digression*: but on account of the great eccentricity of the planet's orbit, its maximum digressions are subject to considerable variation. The greatest digression of Venus is about 47½°, and it admits of a variation amounting to about 2° 48′. When the digression of an inferior planet attains its maximum, the visual ray along which it is seen is a tangent to the orbit, and the planet appears for some days nearly stationary. The more recent term *elongation* has now altogether taken the place of *digression*, and the term as expressing the greatest angular distance from the sun is confined to the inferior planets above named.

Dihedral Angle. In Geometry, denotes the mutual inclination of two intersecting planes; or more accurately the *quantity of turning*, around the intersection of two planes, which would be required to make one coincide with the other. It is obviously equal to the angle between the two lines drawn one in each plane, from any point of, and perpendicular to, the intersection of the two planes.

Dii Consentes. [CONSENTES DII.]

Dike. A term employed by Geologists to express a kind of wall of mineral matter, cutting through strata in nearly a vertical direction; it is generally applied to masses of eruptive matter of subterranean origin, such as trap and green-stone dikes. There is little difference between dikes and veins; for, to quote Lyell, dikes are generally of larger dimensions, and have their sides parallel to a considerable distance; while veins have generally many ramifications, and these often thin away into slender threads. The two designations are in fact nearly synonymous.

Dilapidation (Lat. dilapidatio). In Ecclesiastical Law, is where an incumbent of a benefice suffers the parsonage house or outhouses to fall down or be in decay for want of necessary repairs, or commits any wilful waste of the inheritance of the church. Proceedings against an incumbent for dilapidations must be in the spiritual court. Against his executors, the remedy is either by proceeding in that court, or the successor may have an action of debt or on the case for damages at common law.

Dilatation. [EXPANSION.]

Dilemma (Gr.). In Logic, a species of argument in the form of a complex conditional syllogism. [SYLLOGISM.] It has been divided by logical writers into—1. The simple constructive dilemma, in which the major premiss contains several antecedents all with the same consequent; the minor premiss grants that some one of these antecedents is true; and the conclusion infers that the common consequent is true: e.g. If A is B, C is D; and if X is Y, C is D; but either A is B or X is Y, therefore C is D. 2. The complex constructive dilemma, in which the several antecedents have each a distinct consequent; and it being granted that one antecedent is true, it follows that one consequent is true: e.g. If A is B, C is D; and if X is Y, E is F; but either A is B or X is Y, therefore either C is D or E is F. 3. The destructive dilemma, properly so called, has several antecedents with each a different consequent; and by denying the consequents disjunctively (i.e. denying that one or the other consequent is true) in the minor premiss, we proceed in the conclusion to deny the truth of one or the other antecedent: e.g. If A is B, C is D; and if X is Y, E is F; but either C is not D or E is not F, therefore either A is not B or X is not Y. Every dilemma may be reduced into two or more simple conditional syllogisms.

In the ordinary sense of the word, a dilemma is an argument in which two or more propositions are pressed upon the mind in such a manner that by granting which we will we are compelled to infer the same conclusion. One of the most celebrated dilemmas is that of the philosopher Protagoras in reference to his pupil Euathlus; for an account of which, see the *Athenian Letters*, vol. i. p. 149.

Dilettante (Ital.). A term naturalised in France, England, and Germany; signifying an amateur, chiefly of music, but also of the kindred sciences. There has existed in England, since the year 1760, a society called the *Dilettanti Society* (originally instituted by a gentleman who had travelled in Italy), for perpetuating in each other's company the pleasure they had derived from their residence in that country: but its objects soon became materially extended; and it has acquired universal celebrity by the liberality with which it has devoted its funds to the purposes of science and art. Some of the most famous travellers in Greece and Asia Minor, among whom we may

mention Chandler, have been sent out at the sole expense of the Dilettanti Society; and many works illustrative of art and science, which would otherwise in all probability never have seen the light, have under their auspices been given to the world.

Diligence. In Scottish Law, a general term, comprehending the process of law by which persons, lands, or effects are seized in execution or in security for debt. It is divided into that against the *heritage*, that against the *movables*, and that against the person of the debtor; of each of which there are several species. [INHIBITION; ADJUDICATION; POINDING; SEQUESTRATION; HORNING.] Diligence is also the name of the warrants issued by courts for enforcing the attendance of witnesses, or the production of writings.

Dill Seed. The seed of the *Anethum graveolens*, or Common Dill. This plant is grown for the supply of the medical market with its seeds: they are warm aromatics, with something of the caraway flavour, and yield *dill water*, and an essential oil, when distilled with water. Dill water is a useful remedy in flatulency and gripes of children.

Dilleniaceae (Dillenia, one of the genera). A natural order of chiefly arborescent hypogynous Exogens inhabiting the hotter parts of the world. They are allied to *Magnoliaceæ*, from which they are distinguished by their want of stipules, and the quinary arrangement of the parts of fructification. They differ from *Ranunculaceæ*, to which they are also akin, in their persistent calyx and in their habit, and are universally characterised by the presence of an aril. Their properties are generally astringent.

Dillnite. A mineral from Dillna, near Schemnitz. It appears to be a hydrated silicate of alumina. [COLLYRITE.]

Diluents (Lat. diluo, *I wash away*). Water and aqueous drinks, which increase the secretion of urine and the perspiration, and appear to dilute the fluids of the body, are medically spoken of as *diluents*.

Diluvial Formations. Deposits that are the result of an unusual and extraordinary rush of water, carrying with it all kinds of material removed from the surface, or torn up during the progress of a wave. Diluvial action may result from heavy rains, the melting of snow, submarine earthquakes, or other causes. The material accumulated in this way is called DILUVIUM.

Diluvium (Lat.). A term applied by the older geologists to distinguish certain gravels and comparatively recent deposits which appear to be the result of a rush of water, or *deluge*, from the comparatively smaller stones, fine sand, and mud washed down by rivers during their ordinary state, and called *alluvium*. This distinction between alluvium and diluvium has been much lost sight of, and the latter term is now chiefly used in reference to gravels of one geological period, namely, that of the Boulder clay. [BOULDER CLAY and DRIFT.]

Dimagnetite. A mineral composed of the two oxides of iron, found near New York.

Dimerans, Dimera (Gr. δίς, and μηρός, *thigh*). The name of a section of Coleopterans, comprehending those which have apparently only two joints in each tarsus; this structure, however, does not in point of fact exist there being always a third rudimental tarsal joint.

Dimidiate (Lat. dimidiatus, *halved*). In Botany, this term is used when one half of an organ is so much the smaller as to appear to be missing, as in the pinnæ and pinnules of some species of *Asplenium*, *Adiantum*, and *Lindsæa*.

Diminished Interval. In Music, an interval which is defective or short of its perfect quantity by a semitone.

Diminuendo (Ital.). In Music, an instruction to the performer to lessen the volume of sound from loud to soft, usually marked thus >.

Diminution (Lat. diminutio). In Architecture, the gradual decrease in the diameter of a column as it rises. [ENTASIS.]

DIMINUTION. In Music, the subject of a figure or canon is said to be taken in diminution when its notes are diminished in length, generally to one half or one quarter of their former time.

Diminutive. In Grammar, is applied to words which, by the addition of one or more syllables to those from which they are derived, soften the meaning or diminish their force and effect. Every language is in a greater or less degree susceptible of diminutives; but in this respect, as is well known, the Italian language surpasses all those both of ancient and modern times.

Dimissory Letters. [LETTERS, DIMISSORY.]

Dimity (Gr. δίμιτος, *of two threads*). A cotton cloth of a thick texture, and generally striped or otherwise ornamented in the loom; it is chiefly used for articles of female dress, and for bed furniture and window curtains, and is very rarely dyed.

Dimorphine (Gr. δίς, and μορφή, *form*). The name given by Scacchi to the Orpiment found with Realgar on Vesuvius, because he considered it to be a particular sulphide of arsenic susceptible of assuming incompatible forms.

Dimorphism. The property of assuming two distinct crystalline forms.

Dimorphodon (Gr. δίς, μορφή, and ὀδούς, *tooth*). In this genus of Pterosaurian reptiles, the teeth are of two kinds; a few at the fore part of the jaws are long, large, sharp-pointed, with a full elliptical base; behind them is a close-set row of short, compressed, very small lancet-shaped teeth. There is no evidence of a tail. Such animals are found in the lower lias of Dorsetshire and Lyme Regis.

Dimyarias, Dimyariae (Gr. δίς, and μυών, *a knot of muscle*). All those bivalves or conchifers are so called which have two distinct and separate adductor muscles, and consequently two corresponding muscular impressions on each valve.

Dinosauria (Gr. *δεινός, terrible*, and *σαῦρος, lizard*). An order of extinct reptiles, characterised by cervical and anterior dorsal vertebræ with par and diapophyses, articulating with bifurcate ribs; dorsal vertebræ with a neural platform, sacral vertebræ exceeding two in number; body supported on four strong unguiculate limbs. The genera *Iguanodon*, *Hylæosaurus*, *Scelidosaurus*, and *Megalosaurus* form the solitary gigantic representatives of the order. The Dinosaurian reptiles are found in the mesozoic strata from the Lias to the Wealden inclusive.

Diocese (Gr. διοίκησις). The territorial extent of a bishop's jurisdiction, embracing several parœciæ or parishes. As in early times the Christian converts were most numerous or most easily collected into a congregation in large towns, so in these towns did the bishop reside and minister to the faithful in his church, assisted by his priests and deacons. When the number of believers required the accommodation of additional temples, or congregations were formed in the neighbouring villages, the bishop was wont to appoint priests for their service, and the districts inhabited by these subsidiary congregations would become the parishes of his diocese.

Diodon (Gr. *δίς*, and *ὀδούς, a tooth*; *two-toothed*). The name of a genus of Plectognathic fishes with undivided jaws, each with a single and continuous dental plate.

Diœcious or **Dioicous** (Gr. *δίς*, and *οἶκος, a house*). In Botany, that condition of structure in which the sexes of a plant are borne in different flowers by distinct individuals, as occurs in the Willows.

Dionysia (Gr. *τὰ Διονύσια*). Festivals of Dionysus, but more particularly those that were celebrated in Attica, which were three in number, distinguished by the following titles: 1. The Country Dionysia (*τὰ κατ' ἀγρούς*); 2. Those in Limnæ (a part of the city of Athens, where they were held), which were also called Lenæan (*τὰ Λήναια*, from *ληνός, a wine-press*); and 3. The Great Dionysia (*τὰ μεγάλα*). At all of these festivals the chief amusements consisted in the representation of stage plays; but the last was most celebrated, as then the great contests were held which brought out the marvellous powers of the tragic poets of Athens. [BACCHANALIA.]

Dionysus (Gr. *Διόνυσος* or *Διώνυσος*). A god who by the Greeks as well as the Romans was also called Iacchus and Bacchus. An almost inextricable mass of legend has gathered round the name of this god of wine and feasting. The mountain Nysa, from which he is said to have derived his name, is found in many lands; and the myths which tell the several incidents of his life are as various as those which belong to Heracles. The so-called Homeric *Hymn to Dionysus* gives the Bœotian legend, in which Dionysus has the powers of transformation attributed to Proteus. According to this tale, he goes from Orchomenus to Egypt; and after travelling over many Eastern lands, returns to his old home with new religious rites, the introduction of which is in vain opposed by Pentheus. Finally, he leads out of Hades his mother Semele, who appears in the assembly of the gods under the name Thyônê.

Diophantine Analysis. A branch of Algebra which treats of indeterminate questions, of which the following may serve as a very simple example: *To find three* (*commensurable*) *numbers such that the sum of the squares of two of them shall be equal to the square of the third.*

The name *Diophantine* is derived from Diophantus, a mathematician of Alexandria, who is supposed to have lived in the third century of our era, and who examined and resolved a great number of questions of this nature in his celebrated treatise on arithmetic. Of this work, which exhibits the state of algebra among the Greeks, there are two editions: one by Bachet at Paris, in 1621; the other at Toulouse, in 1670, which is enriched by some valuable notes of Fermat. The student of indeterminate analysis will find the above subject treated in Legendre's *Théorie des Nombres*, Gauss' *Disquisitiones Arithmeticæ*, and Euler's *Algebra*.

Diopside (Gr. *διά*, and *ὄψις, appearance*; from its occasional transparency). A variety of white Augite. A silicate of lime and magnesia. It occurs in oblique rhombic prisms, which are colourless or of various shades of green, translucent or transparent, with a shining lustre, and generally striated longitudinally. The coarse and somewhat friable granular variety is called *White Coccolite*. Crystals are found in veins traversing Serpentine at Ala in Piedmont, and when transparent are sometimes polished and worn as gems.

Diopsis. The name of a genus of Dipterous insects, remarkable for having the eyes and antennæ situated at the extremity of slender horny peduncles rising from the sides of the head, and equalling in some species the entire length of the body.

Dioptase or **Emerald Copper-ore** (Gr. *διόπτομαι, to see through*; because the natural joints are visible by transmitted light). A hydrated silicate of copper, composed, when pure, of 38·3 per cent. of silica, 50·3 oxide of copper, and 11·4 water. This beautiful but rare mineral is found in hexagonal crystals, and in small amorphous masses, of an emerald-green colour, with a vitreous lustre, and varying from transparent to translucent. It occurs in cavities in compact limestone at Altyn-Tübé, in the Kirghese steppes of Siberia; and, also, in the duchy of Nassau between Oberlahnstein and Braubach. [ACHIRITE.]

Dioptrics (Gr. *δίοπτρον, something transparent*; from *διά, through*, and *ὄπτομαι, I see*). A branch of Optics, of which the object is to investigate and explain the effects of the refraction of light when it passes through different media, as air, water, glass, &c. Its principal application is to the construction of telescopes and microscopes, and other instruments which require the use of refracting lenses. The term

is not much used by modern writers on optics, the phenomena to which it refers being treated under the general head of *Refraction*. [LENS; LIGHT; OPTICS; REFRACTION.]

Diorama (Gr. διά, *through*, and ὁράω, *I see*). A mode of painting or scenic representation, invented by two French artists, Daguerre and Bouton, and recently brought forward as a public exhibition in all the principal cities of Europe.

The peculiar and very high degree of optical illusion produced by the diorama depends upon two principles; the mode of exhibiting the painting, and the manner of preparing it. With respect to the first of these, the spectator and the picture are placed in separate rooms, and the picture viewed through an aperture, the sides of which are continued towards the picture, so as to prevent any object in the picture room from being seen excepting the painting itself. Into the room in which the spectator is placed no light is admitted excepting what comes through this aperture from the picture; he is thus placed in comparative darkness, and also (which contributes to the effect) at a considerable distance from the picture. The picture room is illuminated from the roof, which is glazed with ground glass: and the picture so placed that the light falls on it at a proper angle to be reflected towards the aperture. The roof, which is invisible to the spectator, is provided with an apparatus of folds or shutters, by which the intensity of the illumination may be increased or diminished at pleasure, and so modified as to represent, with great effect and accuracy, the different *accidents* of light and shade, or the changes of appearance depending on the state of the atmosphere; as bright sunshine, cloudy weather, or the obscurity of twilight.

The second principle consists in painting certain parts of the picture in transparency, and admitting a stream of light upon it from behind, which, passing through the picture, produces a brilliancy far surpassing what could be obtained by illuminating the picture in the ordinary way, and renders the relief of the objects represented much stronger and more deceptive. Hence, the diorama is peculiarly adapted for representing architectural objects, as the interiors of cathedrals, &c.

In order to render the exhibition more attractive, it is usual to present more scenes than one. This may of course be effected by removing one picture and substituting another; but with a view to prevent the illusion from being impaired by the accidents incidental to scene-shifting, a different method is sometimes resorted to. In the diorama formerly exhibited in the Regent's Park, the spectator was seated in a rotunda about forty feet in diameter, which turned round a vertical axis by means of machinery placed under the floor. There were two picture rooms contiguous to each other, each containing a view; and when the scene was to be changed, the rotunda was turned round until the aperture in front of the spectators which was first opposite to the opening into one of the picture rooms was placed directly opposite the opening into the other. This contrivance, however, it will be observed, is independent of the principles peculiar to the diorama.

Dioscoreaceæ (Dioscorea, one of the genera). A natural order of Dictyogens, inhabiting the tropics, and agreeing with *Smilaceæ* by the genus *Tamus* in having an inferior fruit; but differing from it by the threefold character of inferior ovary, capsular fruit, and the albumen having a large cavity. The mealy tubers of various species of *Dioscorea*, under the name of Yams, form an important food in all tropical countries; and those of *D. Batatas*, a species recently obtained from China, are sometimes cultivated as an esculent in the gardens of this country.

Diosmin (Gr. ὀσμή, *scent*). A non-azotised matter contained in the leaves of Bucku, *Barosma crenulata*, *crenata*, &c.

Diospyros (a word coined from Gr. Διός, *divine*, and πυρός, *wheat*). A genus of arboreal *Ebenaceæ*, mostly found in tropical Asia. They are diœcious plants with fleshy fruits, of which those of *D. Kaki*, the Chinese Date Plum, which is as large as an apple and bright red in colour, is made into sweetmeats by the Chinese. Those of *D. virginiana*, called the Persimon, are very austere and astringent, but when bletted become eatable; a kind of beer and also a spirit are sometimes obtained from them. The most important product of the genus, however, is its timber, ebony wood being obtained from several of the species, as *D. reticulata*, *Ebenum*, *Melanoxylon*, and *Ebenaster*. The hard black ebony consists of the heart-wood only, the sap-wood being soft and white. *D. quæsita* yields the beautiful Calamander wood of Ceylon.

Dip. In Magnetism, the angle which a magnetic needle makes with the plane of the horizon, when poised on its centre of gravity and at liberty to turn in the vertical plane. [DIPPING NEEDLE.]

Dip of the Sea Horizon. In Navigation, the altitude of a heavenly body observed from a place above the surface of the sea, as from the deck of a ship, will evidently be greater than the altitude observed from the surface, since the observer brings the image of the body down to his horizon, which is lower than the horizon seen from the surface beneath him. The difference of the altitudes from this cause is called the *dip*. If the height of the spectator above the surface of the sea be a feet, then the correction for dip $= 1{\cdot}063\sqrt{a}$. This value of the dip, however, is affected by refraction; but the amount of this cannot be very accurately determined on account of the variable nature of refraction at low altitudes. Experiments seem to show that refraction diminishes the amount of dip by about $\frac{3}{40}$ths of itself; hence the common table of dip used in Navigation may be computed from this formula: dip $= \frac{37}{40} \times 1{\cdot}063 \times \sqrt{a} = {\cdot}984\sqrt{a}$.

Dip and Strike. The various strata of

the series of stratified rocks as they now appear are rarely quite horizontal or parallel to the earth's surface. When inclined to the horizon, they must cut the surface in a line, and this line, called the OUTCROP of the rocks, has a definite direction, which in geological language is called the STRIKE, from the German word *streichen*. The strike of rocks is therefore the compass direction of the intersection of their plane of stratification with the plane of the horizon.

When strata are moderately regular, the line of strike is a very useful fact to determine, as it enables the geologist to follow the same bed; and when concealed, covered up, or lost for a time, it suggests the place where he should seek for and endeavour to recover it.

But if beds have a strike, they must be inclined to the horizon. This is their dip [DIP], and must be at right angles to the strike, for that is the direction in which the plane of the bed dips down towards the interior of the earth. Beds dipping at a high angle are soon lost sight of, being generally covered up by other deposits of newer date. In the direction opposite to that of the dip, beds of older date come up from below or *crop out*. The series and sequence of deposits is made out by observations of dip and strike.

The direction of the inclination of a bed is necessarily at right angles to the line of strike. One observation therefore determines these two matters. The amount of inclination is required for practical purposes, and can be measured by a simple instrument. [CLINOMETER.]

Diphanite (Gr. δίς, and φαίνομαι, *I appear*). A mineral allied to Margarite, found in the Emerald mines of the Ural, on brown micaceous slate. The crystals (regular six-sided prisms with a perfect cleavage parallel to their basis) appear blue and transparent on one side, with a vitreous lustre; but on the cleavage faces, they appear white and opaque, when in tolerably thick laminæ, and have a nacreous lustre.

Diphtheria (Gr. διφθέρα, *a skin or membrane*). A disease attacking the throat, characterised by the exudation of lymph upon the tonsils and posterior fauces, extending frequently to the glottis and larynx, and sometimes even to the pharynx, œsophagus, and stomach. The external parts are frequently much swollen, deglutition and respiration are interfered with, and the patient may sink from suffocation. The disease appears to be the result of a poison introduced into the blood. Symptoms of great prostration are generally early observed, but mild cases now and then occur. It has been conjectured by some writers that diphtheria was known at the end of the sixteenth century in the Old and the New World, and that at a later date it destroyed the celebrated Washington, and also the Empress Josephine. The experience of the present generation commenced, however, but a few years ago, when the disease appeared at Boulogne, and ran an epidemic course through the north of France and the south of England. It received the name of *the Boulogne sore throat*. In severe and in fatal cases this disease produces an excretion of albumen in the urine, and paralysis in various forms is a frequent sequel.

The treatment of diphtheria in its severer forms consists in the exhibition of alcoholic and other stimulants, and fluid nourishment, at frequent intervals. The removal of the membrane formed in the throat is effected by the application of caustic solutions, dilute acids, or the inhalation of stimulating vapours. In the mild cases, which are unfortunately of less frequent occurrence, little treatment is required beyond the regulation of the bowels and attention to diet.

Diphthong (Gr. δίφθογγος). In Grammar, this name is given to what are called *double vowels*, or the union of two vowels pronounced together, so as only to make one syllable.

Diphyans, Diphyes (Gr. διφυής, *double*). A family of *Acalephans*, comprehending those singular species in which two distinct individuals are always conjoined, one being lodged in the concavity of another.

Diphyodonts (Gr. δίς; φύω, *I generate*; and ὀδούς, *tooth*). Those mammalia in which two sets of teeth are generated in the alveoli of the jaw. Zoologists have been led, chiefly by the state of the dentition in most of the early forms of both carnivorous and herbivorous mammalia, which flourished during the eocene tertiary periods, to regard three incisors, one canine, and seven succeeding teeth, on each side of both jaws, as the type formula of Diphyodont dentition. Three of the seven teeth may be *premolars*, and four may be true *molars*, or there may be four premolars and three true molars. This difference Professor Owen has shown to be a character of a secondary group or order in the mammalian class. The essential nature of the distinction is as follows: true molars are a backward continuation of the first series of teeth: they are developed in the same primary groove of the fœtal gum; they are permanent, because they are not pushed out by successional teeth, the premolars, called *dents de remplacement* by Cuvier. Seven teeth developed in the primary groove is, therefore, the typical number of first teeth, beyond the canines. If, as in *Didelphys*, the anterior three develope tooth-germs which come to perfection in a *secondary groove*, there are then three deciduous teeth, three premolars, and four true molars. If, as in *Gymnura*, the anterior four of the primary teeth develope tooth-germs, which grow in a secondary groove, there are then four deciduous teeth, four premolars, and three true molars. The first true molar of the marsupial is thus seen to be the homologue of the last milk-molar of the placental. When the milk-teeth are shed, and the permanent ones are all in place, their kinds are indicated, in the genus *Sus*, by the following formula:—

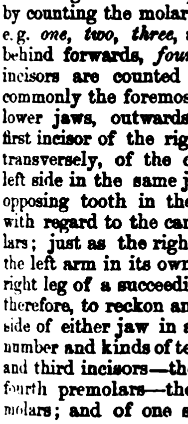
$$i.\ \frac{3-3}{3-3},\ c.\ \frac{1-1}{1-1},\ p.\ \frac{4-4}{4-4},\ m.\ \frac{3-3}{3-3}=44.$$

Each tooth is distinguished by its appropriate

symbol, e.g. *p.* 1 to *p.* 4, *m.* 1 to *m.* 3, and this number of teeth is never surpassed in the placental Diphyodont series. When the premolars and the molars are below this typical number, the absent teeth are missing from the forepart of the premolar series, and from the back part of the molar series. The most constant teeth are the fourth premolar and the first true molar; and these being known by their order and mode of developement, the homologies of the remaining molars and premolars are determined by counting the molars from before backwards, e.g. *one, two, three,* and the premolars from behind forwards, *four, three, two, one.* The incisors are counted from the median line, commonly the foremost part of both upper and lower jaws, outwards and backwards. The first incisor of the right side is the homotype, transversely, of the contiguous incisor of the left side in the same jaw, and vertically, of its opposing tooth in the opposite jaw; and so with regard to the canines, premolars, and molars; just as the right arm is the homotype of the left arm in its own segment, and also of the right leg of a succeeding segment. It suffices, therefore, to reckon and name the teeth of one side of either jaw in a species with the typical number and kinds of teeth, e.g. the first, second, and third incisors—the first, second, third, and fourth premolars—the first, second, and third molars; and of one side of both jaws in any case.

Dipleidoscope (a word made up from Gr. διπλόος, *double*; εἶδος; and σκοπέω, *I view*). An optical instrument for indicating the passage of the sun, or a star, over the meridian, by the coincidence of two images formed by a single and double reflexion.

The instrument is constructed as follows: A B, A C, and B C are three reflecting planes, one of which, A B, is transparent, and the other two of silvered glass, the three forming an equiangular prism. Suppose the side A C to be placed exactly in the plane of the meridian, and a pencil of light proceeding from the sun, S, to fall upon the transparent plane A B at *a*, in the direction S *a* parallel to A C. A portion of this light will be reflected from *a* in the direction *a e*, which is such that the angle *e a* B is equal to S *a* A. Another portion of it will pass through the transparent plane A B, and, proceeding in the same direction, will fall on the silvered mirror at *b*, where it will suffer a total reflection in the direction *b c*, and, falling on the second silvered mirror at *c*, will be again reflected in the direction *c d*, and will pass through the transparent plane A B, and continue its course in the same direction *c d* E. Now, the angles of incidence and reflection being equal, when S *a* is parallel to A C, then *b c* is parallel to A B, and *c d* to C B, and the direction *d* E to *a e*, so that an eye at E or *e* will see only a single image of the sun S. But if S *a* be not parallel to A C, then *d* E will not be parallel to *a e*, and a double image will appear. Suppose, for instance, the sun's course to be in the direction from A towards B; then, before the sun comes to the meridian, the pencil of light S *a* will make with A B an angle S *a* A less than 60°. Consequently, the reflected ray *a e* will make the angle *e a* B less than 60°. But in this case the angle E *d* B will be greater than 60°, and therefore two images will be seen by the eye at E, one in the direction *e a*, and the other in the direction E *d*. The first of these will appear to move with the sun in the direction A B, and the second in the opposite direction B A; they will approach each other until S *a* becomes exactly parallel to A C, when they will coincide; after this, as the angle S *a* A becomes greater than 60°, they will separate, and gradually pass off the field, one at B, and the other at A. Hence it is evident that if A C be in the plane of the meridian, the instant of the coincidence of the two images will be that of apparent noon.



When used as a meridian instrument, the dipleidoscope must be fixed so that one of the reflecting planes, A C, is exactly vertical, and also in the meridian. The latter adjustment may be made by any of the means which suffice for fixing a sun-dial, or for drawing a meridian line: the former, by suspending a fine plumb-line a few feet before the transparent glass, and moving the instrument slowly about the edge A C till the two images of the line become exactly parallel. These are the only essential adjustments; but it is convenient also to fix the instrument so that the lines of intersection of the three planes may be parallel to the axis of the earth's rotation, in order that the sun's greatest altitude above the plane of the instrument at midsummer may be equal to his greatest depression below it at midwinter. On account of the intense light of the sun, the eye must be protected by a coloured glass; and the field of view may be magnified by a small telescope. Three observations should be made; the first, of the instant at which the two images come into contact; the second, of the instant at which they exactly coincide; and the third, of the instant at which they separate. The instrument, if accurately made and fixed, is capable of giving true time within a fraction of a second.

Diploe (Gr. διπλόω, *I double*). The horny or spongy substance between the tables of the skull.

Diploma (Gr.). Every sort of ancient charter, donation, bull, &c. is comprehended by writers on diplomatics under the name *diploma*. The term is derived from the earliest charters of donation with which we are acquainted, those of the early Roman emperors having been inscribed on two tablets of copper joined together so as to fold in the form of a book. The form and character of the diploma granted

by the sovereigns, prelates, nobles, &c. of modern Europe, varied from age to age; and the knowledge of these variations forms an important branch of the science of diplomatics.

Diplomacy. In a restricted sense, this term is used to express the art of conducting negotiations or arranging treaties between nations by means of their foreign ministers, or written correspondence; but, in its more extended signification, it denotes the whole science of negotiation with foreign states, which embraces:—

1. The law of nations, by which the relations of one state with another are determined both in peace and war.

2. The political principles of individual states, as deduced from a regard to their peculiar interests; and a knowledge of the way in which these interests may be reconciled with, and made subservient to, the law of nations.

3. An acquaintance with the privileges and duties of diplomatic agents.

4. The conduct of negotiations, or the course to be pursued in treating of the interests of different states.

5. The moral and physical statistics of each power.

6. The political and military history of the states having diplomatic relations; and the projects, tendency, and policy of their respective governments.

7. The various systems of government, supremacy, concession, retention, equilibrium, centralisation, confederacy, &c., that may be brought into operation.

8. The art of composing diplomatic despatches.

To this multifarious information the diplomatist should unite the powers of calculation and application peculiar to strong minds—the *tact des convenances*, which may be felt, but cannot be expressed—circumspection, address, and perfect integrity. The combination of these various qualities will procure for the diplomatist such a character for sagacity, rectitude, and straightforwardness, as will sooner or later obtain for him an ascendency over the minds of others, and give great weight to his opinions.

It must be remembered that the diplomacy of every nation is more or less within the range of casualties; being subject to the versatility inseparable from human affairs, the fickleness and passions of man, and the uncertainty of events; an unlooked-for death, a change of ministry, treacherous designs, undue influence from any quarter, a false calculation, corruption: each of these causes may change the policy or course of a government; and this will more or less affect every other government, in proportion to the extent of its influence. In addition to these numerous causes of variation, if ambitious projects be entertained by any great power, diplomacy becomes still more intricate and difficult. Every state desires to be protected against the storm which its rulers imagine they can prognosticate, and of whose bursting they are apprehensive. Again, we must remark that the schemes of a government, how admirably soever contrived, have often miscarried, either from subordinate persons or those who are intrusted with putting them in execution having misapplied or misunderstood the instructions of their superiors.

From what has been said, it will be easily understood that, in diplomacy, false estimates are frequently formed of the merits of original plans or designs from looking at their results only. The diplomatist is of course exempted from all responsibility in regard to operations mixed up with the events of war; he is answerable only for the success of his projects under the conditions on which he proposed them.

A diplomatist of moderate capacity, if favoured by circumstances, may accomplish much more than the man of genius who has to contend with adverse fortune; but this difference of success makes no change in their relative ability, and those who are acquainted with the circumstances readily discriminate between sagacity and accident.

Diplomacy has been practised in substance ever since mankind have been formed into independent states, though it is difficult to ascertain the precise period at which the term came into use. The system, however, of the regular and uninterrupted residence of foreign ministers during peace at the European courts, as at present practised, is said to have originated with the cardinal de Richelieu. Before that time embassies had been only sent on special occasions, but attended with much greater show and retinue than has been the fashion in modern times; while the substantial business of states at the neighbouring courts was transacted by agents of a lower stamp and character. Diplomatic agents are now ranked, in Europe, in the following order, according to the regulations of the congress of Vienna: 1. Ambassadors; 2. Envoys extraordinary and ministers plenipotentiary; 3. Ministers resident; 4. Chargés d'affaires; 5. Secretaries of legation and attachés: the latter, however, have no precise diplomatic character, and are only considered by courtesy as attached to the legation.

Among the best works on this important subject are the *Traité complet de Diplomatie, ou Théorie générale des Relations extérieures des Puissances de l'Europe*, par M. le Comte de Garden (Paris 1833), 3 vols. 8vo.; and De Wicquefort's *Ambassadeur et ses Fonctions* (Ed. Opt.), 1746, 12 vols. 4to. See also the *Manuel Diplomatique*, by Von Martens (Paris 1825); Flassan's *Histoire Générale et Raisonnée de la Diplomatie Française*, 7 vols. (Paris 1811); and Von Martens' (senior) *Grundriss einer Diplom. Geschichte der Europ. Staatshandel*, &c. (Hamburg, 8vo.).

Diplomatics. The science of deciphering ancient writings, assigning their date, &c. The name is derived from DIPLOMA [which see]. Writings of earlier date than the fifth century were mostly on the leaves of the papyrus, or

Biblos Ægyptiaca. Parchment appears to have been first generally used in that century; and the oldest documents bearing the character of diplomas which we possess do not extend to a higher antiquity. Not long after the general adoption of parchment, a variety of substances and colours began to be used in writing, as vermilion, purple, gold, and silver; but this sumptuous fashion did not long remain in use. The science of diplomatics teaches the different styles and forms adopted in ancient public documents; the titles, rank, &c., of public officers whose names are subscribed to them; the knowledge of the materials used in writing in different ages, of the different characters used in successive periods and in various countries; and the several kinds of diplomas or public instruments.

This science is said to owe its origin to a Jesuit of Antwerp, named Pabebroch, who devoted himself to the research and exposition of old diplomas about the year 1675; but the honour of having established it on a sure foundation is due to Mabillon, whose learned work, *De Re Diplomatica*, was given to the world in 1681. The principles laid down by Mabillon, however, were more fully developed about the middle of last century, in the *Nouveau Traité de Diplomatique*, which has left little to be done by subsequent labourers in this field beyond the duty of translation, compilation, or abridgement. We subjoin a list of the most important works on this science, arranged according to their dates of publication; from which it will be seen that the French and Germans have prosecuted this science with an energy and enthusiasm to which, considering its importance, our national literature presents a humiliating contrast. Besides the work of Pabebroch above referred to, entitled the *Propylæum*, there are: Mabillon, *De Re Diplomatica*, 6 vols. fol. (Paris 1681), to which a supplementary vol. was added in 1704; *Historia Diplomatica*, by Maffei, 4to. (Mantua 1727: this work may be regarded as merely a supplement to Mabillon); *Chron. Waltheri Lexicon Diplom.* 3 vols. fol. (Göttingen 1745–7); Hermann von Teutschenbrunn, *Commenta. de Re Diplom. Regum*, &c. 4to. (Nuremberg 1745); *Nouveau Traité de Diplomatique*, by the Benedictine monks Toussaint and Tassin, 6 vols. 4to. (Paris 1750–65); De Vaine's *Dictionnaire Raisonné de Diplomatique*, 2 vols. 8vo. (Paris 1774: this work is intended chiefly to aid beginners in the science); Gatterer, *Abriss der Diplomatik*, 8vo. (Göttingen 1798); Schœnemann's *Prolusio de finibus Artis Diplom. Pract. Regundis*; and his *Versuch eines Vollständ. Systems der Allgem. besonders ältern Diplomatik*, 8vo. (Göttingen 1802).

Diploneurans, Diploneura (Gr. διπλόος, *double*, and νεῦρον, *nerve*). A name applied by Rudolphi to that division of the animal kingdom comprehending the species which have two nervous systems, viz. the ganglionic or sympathetic, and the cerebro-spinal; the series so designated corresponds with the *Vertebrata* of Cuvier.

Diplopia (Gr. διπλόος, and ὄπτομαι, *I see*). Double vision. This affection occasionally is symptomatic of nervous irritability, worms, indigestion, hysteria, &c.

Diploptera (Gr. διπλόος, and πτερόν, *a wing*; *double-winged*). The name of a division of Aculeate Hymenopterous insects, comprising those species of wasp which have the upper wings folded or doubled up longitudinally when at rest.

Diplozoon (Gr. διπλόος, and ζῷον, *animal*; *double animal*). The name of a very singular parasitic worm, which infests the gills of the bream, and which appears to be formed of two distinct bodies united in the middle, so as to present the appearance of a St. Andrew's cross, each half of the animal containing precisely the same organs, viz. an alimentary canal, a sanguiferous and a generative system.

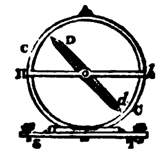
Dipneumoneans, Dipneumones (Gr. δίς, and πνεύμων, *a lung*; *two-lunged*). A term applied to a section of spiders (*Araneidæ*), including those which have only two pulmonary sacs.

Dippel's Oil. An empyreumatic oil, produced during the destructive distillation of bone.

Dipper. A name commonly given to the water-ouzel and other species of the genus *Cinclus*.

Dipping Needle. An instrument for showing the direction of one of the components of the earth's magnetism. Its axis is at right angles to its length, and passes as exactly as possible through its centre of gravity, about which it moves in a vertical plane. When a needle thus mounted is placed anywhere not on the magnetic equator, it *dips*, or points downwards; and if the vertical plane in which it moves coincides with the magnetic meridian (which is always known by means of a variation compass), the position which it assumes shows at once the direction of the magnetic force; and the intersection of two or more directions, found by making the experiment at different places, indicates the place of the magnetic pole. Though the principles on which the dipping needle acts are abundantly simple, its practical construction is found to be exceedingly difficult. It must be accurately balanced on its axis; the axis must be placed exactly horizontal; the friction must be diminished to the utmost extent possible; and the adjustments can only be made when the needle is perfectly free from magnetism, and also secured from the effects of the magnetic influence of the earth. It must be subsequently magnetised, and during this process much care is required to guard against derangement. The simplest construction is represented in the following figure. The needle D *d* consists of a flat oblong piece of steel, tapering to a point at both ends, and having a slender cylindrical axis passed through its centre of gravity. The axis moves freely in circular holes

made in the lateral horizontal bars H *h*, which support a vertical circle C C, graduated for the purpose of showing the inclination of the needle to the horizon. The stand S T, to which the circle is fixed, is provided with levels, and adjusted to horizontality by means of screws. But in the most improved form of construction of the dipping



needle, the axis, instead of being a cylinder, is a knife edge, resting perpendicularly, like the supports of a pendulum, on two agate planes. A needle thus supported, however, must necessarily make small oscillations; consequently it must be so adjusted that when it points in the direction of the magnetic force, the knife edges may be perpendicular to the agate planes. The mean value of the angle of the dip must therefore be known previously to its construction; but it is the best adapted, on account of its delicacy, for ascertaining the minute variations of the dip at the same place. The angle of the dip, like that of the variation, changes its value even at the same place, following of course the motion of the magnetic poles, which, from the observations made by Scoresby, Parry, Ross, and others in high latitudes, appear to have a motion westward, the annual amount of which is about 11′4″. In the summer of 1831 Commander Ross, in an excursion from the vessel in which his party were so long detained in the polar seas, reached a spot on the continent of North America which had been calculated to be the position of the magnetic pole. There he found the dip of the needle to be 89° 59′, within one minute of the vertical; and compass-needles suspended in the most delicate manner possible exhibited no polarity whatever. The latitude of this spot is 70° 5′ 17″ north, and its longitude 96° 46′ 45″ west. (For a description of some other forms of the dipping needle, see Brewster's *Treatise on Magnetism* [MAGNETOMETER.]

Diprotodon (Gr. δίς; πρῶτος, *first*; and ὀδούς, *tooth*). A genus of Marsupials found in the pliocene caves of Australia, which presents the closest analogy in its dentition to the existing Kangaroos (*Macropus*), but with an osculant relationship with the herbivorous wombat. The skull measures three feet in length. The limbs were modified to present a more pachydermal character than those of the existing *Macropidæ*. The dental formula is

$$i.\ \frac{3-3}{1-1},\ c.\ \frac{0}{0},\ p.\ \frac{1-1}{1-1},\ m.\ \frac{4-4}{4-4}=28.$$

Dipsaceæ (Dipsacus, one of the genera). In Botany, a natural order of herbaceous Exogens, of the Campanal alliance, chiefly inhabiting the south of Europe. They are nearly allied to *Compositæ*, but differ in their stamens being distinct, and their ovule being pendulous. They are distinguished from *Calyceraceæ* by the latter having connate anthers and alternate leaves; and from *Valerianaceæ* by their capitate flowers, and the presence of albumen. Their properties are unimportant. *Dipsacus Fullonum*, the Fuller's Teasel, is employed mechanically, for the sake of the hard stiff bracts of its flower-heads, in the process of dressing woollen cloths.

Dipsas (Gr. a serpent whose bite caused *thirst*). This term has been applied by Laurenti to a genus of Colubrine serpents; and by Dr. Leech to a genus of fresh-water Bivalves, intermediate to *Unio* and *Anodonta*.

Dipteraceæ. A natural order of arborescent Exogens, only found in India and the Indian Archipelago. They belong to the Guttiferal alliance, in which they are distinguished by their simple alternate leaves with large stipules, their symmetrical flowers, unequal permanent calyx, bearded anthers, and one-celled one-seeded fruits. Blume traces an affinity with *Clusiaceæ* in their resinous juice, compound superior ovary, drupaceous fruit, numerous long anthers, irregular coloured calyx, and single exalbuminous seed; but from this order the stipules and the æstivation of the corolla abundantly distinguish them. The order is chiefly marked by the enlarged foliaceous unequal segments of the calyx investing the fruit. To it belongs the Camphor-tree (*Dryobalanops Camphora*), which also yields the camphor oil of Borneo and Sumatra; while other species yield pitch.

Dipteral (Gr. δίπτερος, *with two wings*). In Architecture, a temple which had a double row of columns on each of its flanks.

Dipterans, Diptera (Gr. δίπτερος). An order of insects having for their main and most conspicuous character two wings only corresponding to the anterior pair, and two short clubbed appendages, called *halteres* or balancers, and which seem to be the rudiments of the posterior pair in four-winged insects. The Dipterans are also distinguished by having the mouth in the form of a sucker, composed of from two to six lancet-shaped elongated scales, enclosing a canal upon the upper surface of a fleshy tongue or proboscis. The larvæ or maggots of the Dipterous insects have frequently a membranous head; and always have the stigmata, or breathing pores, confined to the second and terminal segments of the body. In some species, as the blow-fly, the eggs are hatched within the body of the parent; in others, as the forest-fly (*Hippobosca*), the larva undergoes its metamorphosis in the parent's body, and the young are excluded in the form of *pupæ*.

Dipterocarpus (Gr. δίπτερος, and καρπός, *a fruit*). A genus of *Dipteraceæ*, consisting of lofty trees of the Indian islands, abounding in resinous juice which is used medicinally and for burning in torches. They have leathery simple leaves, and bear clusters of large fragrant flowers. The calyx is divided into five unequal segments, two of which become very large and leaf-like, forming wings to the one-seeded fruits. *D. lævis* yields a thin liquid balsam called *wood oil*, which is used as a substitute for paint, and mixed with dammer is

valuable in preserving timber from the ravages of the white ant. This wood oil is imported as a substitute for Balsam of Copaiba, which it much resembles.

Dipterygians, Dipterygia (Gr. δίς, and πτέρυξ, *a fin*; *two-finned*). A family of fishes comprehending those which have but two fins.

Dipteryx or **Dipterix** (Gr. δίς, and πτέρυξ, *a wing*). A genus of *Leguminosæ*, consisting of large trees found in the forests of Brazil, Guiana, &c., and being one of the few genera of this order in which the fruit is one-seeded and indehiscent. *D. odorata* yields the coumarin-scented Tonquin or Tonka Bean, employed by perfumers, and for scenting snuff. This tree grows sixty or eighty feet high, and its fruit bears some resemblance to that of the almond. *D. eboënsis* yields an excessively heavy yellowish timber, and its seeds contain a large quantity of fatty oil.

Diptote (Gr. δίς, and πτῶσις, *a case*). In Grammar, a name applied to those nouns which have only two cases.

Diptych (Gr. δίπτυχος, *twofold*). Among the Romans, a tablet of wood, metal, or other substance, used for the purpose of writing, and folded like a book of two leaves: when the book consisted of several leaves, it was termed πολύπτυχος, or *manifold*. The diptychs of antiquity were employed especially for public registers. The sacred diptychs of the Greek church were double catalogues, containing on one side the names of the living, on the other those of the dead, which were rehearsed during the office.

Dipus (Gr. δίπους, *two-footed*). The general name for the Jerboas or Rodent animals, in which the hind-legs are disproportionately developed, and chiefly serve for locomotion. The numerous species referable to the Linnæan genus are now divided into the subgenera *Alactaga*, *Gerbillus*, *Dipus* proper, &c.; and form the family *Dipodidæ*; the *Gerbilli*, however, are more nearly allied to the *Muridæ*.

Dipyre (Gr. δίπυρος, from δίς, and πῦρ, *fire*). A silicate of alumina, lime and soda; composed of 53·8 per cent. of silica, 26·2 alumina, 9·5 lime, and 10·5 soda. It occurs in greyish- or reddish-white translucent or transparent fascicular masses and in slender four-sided prisms, which are indistinctly formed and rounded at the ends like grains of wheat. The name has reference to the double effect produced upon the mineral by fire, which first renders it phosphorescent, and then fuses it. Dipyre is found in clay-slate near Mauléon, in the Western Pyrenees, and in the valley of Castillon.

Direct (Lat. directus, part. of dirigo). In Music, a character used at the end of a staff, to direct the performer's notice to the succeeding note at the beginning of the following staff.

Direct Acting Engines. Those in which the motion of the piston is communicated directly from the head of the piston rod, through the connecting rod, to the crank, without the intervention of side levers or a balance beam. In the modern direct acting engines an attempt has been made to do away with the fly-wheel, and to apply the steam directly to the resistance.

Director. A common surgical instrument: it is generally made of silver, and resembles a grooved probe. Its use is to direct the knife, and protect the parts underneath from its edge or point.

Directors. In Commerce, the name given to the individuals composing the board of management of a joint-stock company; as of the bank of England, &c.

Directory (Fr. Directoire). In French History, the name given by the constitution of 1795 to the executive body of the French republic. It consisted of five persons, called *directors*, who were selected by the council of elders from a list of candidates presented by the council of five hundred. One of these directors retired every year, and was succeeded by another elected on the same principle. To the Directory was intrusted the superintendence of the home and foreign departments, the finances and the army, and the appointment of the ministers of state and other public functionaries. Its policy was at first moderate and conciliatory; but after a short interval it had recourse to measures which produced widespread dissatisfaction, and it was at length overthrown on the ascendency of Bonaparte after an existence of four years. The most complete of the many works on its history, is De Baraute's *Histoire du Directoire*, 1855.

Directory. A book containing the names of the inhabitants of a town, arranged in alphabetical order, together with their places of abode, &c. It is likewise applied to a book containing directions for public worship, or other religious services.

Directrix. In Geometry, usually denotes a right or curved line which serves for the description or definition of a curve or surface. The directrix of a conic is a right line perpendicular to the axis whose distance from any point on the curve bears a constant ratio to the distance of the same point from the focus. [Conic Sections.] Quadric surfaces have also directrices possessing analogous properties. [Focus.] When a surface is conceived to be generated by the motion of a line, right or curved, which always rests on other fixed lines, the latter are sometimes also called *directrices*, but more frequently *directing lines*, or simply *directors*; the former being distinguished as the *generator*. [Ruled Surface.]

Dirge (a contraction of Lat. *dirige*, used in the old formula of the Catholic service for the dead—*Dirige Domine Deus*). A funeral song or hymn.

Dirigents. A term applied in old Pharmacy to certain ingredients in prescriptions which were supposed to *direct* the operation of the others to some particular organ.

Dirk (Ger. dolch, Swed. dolk). A short sword, of dagger form, used by midshipmen and naval cadets in the Royal Navy.

Dirt Bed. A remarkable deposit, in the upper oolites of England, of ancient soil containing the remains of trees that once grew upon it. This bed is from twelve to eighteen inches thick. It is of a dark brown or black colour, and contains a large proportion of earthy lignite. Rounded stones from three to nine inches in diameter are distributed through it, and the silicified trunks of coniferous trees like *Zamia* are buried in it. At Lulworth Cove this bed is found inclined at an angle of 45° to the horizon. At some places the phenomena are more complicated than at others, but the general facts are the same throughout The position of the dirt bed is in the Lower Purbeck series near the top of the middle secondary or mesozoic rocks. Several inches of this black earth or loam containing fragments of fossil wood and the roots of ancient trees may be traced for many miles, marking clearly the position of ancient lands at the period of deposit.

Besides the bed commonly recognised by geologists as the *dirt bed*, there are in various places in other deposits indications of the same kind, but none are so complete and characteristic. The coal measures of some parts of British North America are perhaps among the richest localities of similar phenomena out of England. [OOLITE SERIES and CINDER BED.]

Disability. In Law, signifies a state which renders a person incapable of enjoying certain legal benefits; as the state of an alien renders him incapable of taking lands, that of infancy of making valid contracts, and so forth. Disability, it is said, may happen in four ways; by the act of the ancestor, of the person, of God, or of the law.

Disc or **Disk** (Lat. discus). In Astronomy, the face of the sun, moon, or a planet, such as it appears to us projected on the sky. The forms of the celestial bodies being spherical, or nearly so, their projections are circular planes. When viewed through a telescope, the fixed stars also present the appearance of discs; but as these are due entirely to the effects of diffraction, which vary inversely as the aperture, they are termed *spurious discs*.

Discharge. In Architecture, this term is used to signify the relief, or distribution of a weight, or load to be borne; thus, discharging arches are used in a wall over a lintel, or an opening, to discharge them of the weight which they would otherwise bear.

Disciple (Lat. discipulus). Literally, one who learns the principles of any science or art from another; but the term is used more particularly to signify the followers of any teacher or philosopher whose spirit they have imbibed along with a knowledge of his peculiar tenets.

Discipline (Lat. disciplina). Signifies, primarily, instruction or government; but it is applied figuratively to a peculiar mode of life, in accordance with the rules of some profession or society. It is also used to designate the punishment employed in convents, and those which enthusiasts undergo or inflict upon themselves by way of mortification.

Discipline, Book of. In the church of Scotland, a common order, drawn up by the General Assembly in 1650 for the reformation and uniformity to be observed in the discipline and policy of the church. In this book episcopal government is set aside, Kirk sessions are established, the observance of saints' and other holy days is condemned, and regulations for the internal government of the church are prescribed. It is called the *First Book of Discipline.*

Discipline of the Secret or **Disciplina Arcani** (Lat.). A name given by theological writers to a system pretended to have been in force in the primitive church, by which its most important and mysterious doctrines were concealed from the mass of believers, and fully developed only to a select class.

Disclaimer. In Law, a plea containing an express denial or renunciation of some claim which has been made upon or by the party pleading. It is more especially taken for the denial, by an alleged tenant, of his tenancy. Such disclaimer is punishable at common law by the forfeiture of the land, if, on writ of right *sur disclaimer* brought, the lord succeed in proving the tenancy.

Discoboles (Gr. δισκοβόλος, *quoit throwing*). In Ichthyology, this word is applied to a family of pectoral or sub-brachian fishes, comprehending those which have the ventral fins confluent, and forming a suctoral disc beneath the throat.

Discoid (Gr. δισκοειδής, *disc-shaped*). This term is applied to those univalve shells of which the whorls are disposed vertically on the same plane, so as to form a disc; as in the *genera Nautilus* and *Planorbis*.

Discontinuance. In Law, an injury to real property, which consists in the keeping out the rightful owner of an estate by a tenant whose entry was at first lawful, but who wrongfully retains the possession afterwards: as, where tenant in tail makes a feoffment in fee-simple for life or in tail. In this case the heir in tail, remainder-man, or reversioner, is put to his writ: so alienations made by husbands seised in right of their wives, or by ecclesiastics seised in right of their church, work a species of discontinuance.

Discord (Lat. discordia). In Music, a chord or harmony which produces for the moment an unpleasant effect, or at least which requires to be followed, or, as it is termed, resolved, by a concord following, in order to satisfy the ear.

Discordia. [ERIS.]

Discount. An allowance made for the payment of money before it becomes due. To favour neither party, the discount on a sum of money due a year hence should be the difference between that sum and its *present value*; that is to say, the sum which, in a year's time, at the ordinary rate of interest, would yield the same amount. Thus the discount on a bill of 104*l*. due a year hence should be 4*l*., money being worth four per cent. Bankers and mercantile men, however, are allowed the advantage

of calculating discount as simple interest: they would charge 4*l.* 3*s.* 2½*d.*, a year's interest on 104*l.* at four per cent., for discounting the bill in question.

Discount. In Political Economy. A person possessed of abilities, opportunities, and character necessary for carrying on an industrial occupation may be deficient in the capital requisite for accomplishing his purpose. On the other hand, some other person, whose tastes or whose powers are inadequate for engaging in any other occupation than that to which he is habituated, may have accumulated capital, and desire to employ it for his advantage. As capital is desirable, and the beneficial investment or employment of capital is desirable to both these parties respectively, it will not be difficult to conceive that means should be discovered for bringing these parties together, and for satisfying their several wishes; and as modern societies are large, and the demand and supply of capital may not on this account be easily brought into communication, the further need of some intermediary or other who will engage to find employment for capital, and capital for employment, will not long wait for satisfaction. The person who supplies capital will require some advantage for his loan, or, as Mr. Senior has said, 'a reward for his abstinence' in not employing his capital on his personal gratification; and again the borrower of capital is willing, because he discovers a further profit on the extension of his energies by means of additional capital, to promise the reward or remuneration required. The amount or remuneration demanded for the advance is determined by the joint competition of borrowers and lenders, and is known generally by the name of *interest*. [Interest.]

Discount is only another form of interest. Investments of capital are either made for some long or permanent space of time, or are intended only for short or recurrent periods. The latter are generally made under the conditions of discount; that is, the interest to be paid at the end of the period is deducted from the amount advanced at its commencement. To borrow 100*l.* at four per cent. for three months, and to pay 101*l.* at the end of the period, does not, for the purpose of illustration, differ substantially from taking 99*l.* at once, under the promise to pay 100*l.* at the end of three months. The former transaction would be called *interest*; the latter is the process of discounting a bill of exchange, or other obligation, the date of payment of which is deferred.

The intermediaries to the borrower and lender in mercantile transactions are bankers, bill-discounters and the like. These functionaries employ to some extent their own capital, to a far larger extent the capital of others, in advances upon loan to borrowers; the charge for the accommodation being the discount. The motive inducing the deposit of cash or capital with a banker or bill-discounter is either the convenience of a banking account, and the privilege which the customer of a bank has in securing assistance either by loan or by discount on his paper; or a direct participation in the profits of the advances, by an arrangement allowing depositors a variable rate of interest on their deposits. This method of accumulating capital for banking purposes is especially characteristic of modern or joint-stock banking; and the funds available for commercial purposes, but derived from deposits, are in such banks many times more than the proprietors' capital.

The customary rates of interest and discount have a tendency to equality. But in the ordinary course of trade, the rate of discount is slightly lower than the rate of interest, because there is an advantage in the fact that the loan is rapidly repaid, bills being generally drawn for three months only, and the competition of lenders lowering the rate of discount to the minimum which the supply will permit. When, however, the money market is said to be *tight*, that is when there is a temporary excess of borrowers, either because it is necessary to meet extraordinary obligations, or because speculation is active, or the foreign exchanges are adverse, or the currency is contracted by the exportation of specie, the rate of discount is higher than the rate of interest; the competition of borrowers raising the rate to the maximum which can be extracted from their necessities.

The rate of discount for the time being is determined generally by the directors of the bank of England. This establishment is, however, affected by the same influences which raise or depress the rate in the open market. The Bank itself discounts bills, and if it kept the rate above that which prevails elsewhere, its own profits would diminish; while on the other hand, were its rate less than that at which private bill-discounters can afford to make their advances, the pressure for accommodation would diminish its resources. The publication, therefore, of its minimum rate of discount is always a matter of importance to merchants, because it indicates what, in the opinion of a body of the most eminent men of business, is the rate at which loans can be made for commercial purposes. [Exchange, Bill of; Panic; Money Market.]

Discourse (Lat. discursus). In Rhetoric, a series of sentences and arguments arranged according to the rules of art. In Logic, this term is applied to the third operation of the mind, commonly called *reasoning*. [Logic.]

Discovery. In Law, the act of revealing or disclosing any matter by a defendant in his answer to a bill in chancery. [Chancery.]

Discrase or **Discrasite** (Gr. δίς, and κρᾶσις, *mixture*). Native antimonide of silver. It occurs crystallised and in grains. The colour is silver-white with a metallic lustre.

Discrete (Lat. discretus, *separated*). A term in Mathematics opposed to *continuous*. Thus ordinary numbers are *discrete quantities*, being formed by the successive addition of

units. Again, four numbers are said to form a *discrete proportion* when the ratio of the first to the second, although equal to that of the third to the fourth, differs from that of the second to the third. The numbers 2, 3, 4, 6 possess this property; whereas 2, 4, 8, 16 are *continued proportionals.*

Discriminant (Lat. discrimino, *I separate*). The resultant of the system of equations, formed by equating to zero the several first derived functions of a given quantic, is called the *discriminant* of that quantic; since, when it vanishes, the quantic may always be expressed as a quadric in $(n-1)$ variables linearly related to the n original ones. [ELIMINATION.]

In the case of the ternary quadric

$$u=(a\,b\,c\,d\,e\,f \between x, y, z)^2,$$

the discriminant being the resultant of the system

$$\tfrac{1}{2}\frac{du}{dx}=ax+fy+ez=0,$$

$$\tfrac{1}{2}\frac{du}{dy}=fx+by+dz=0,$$

$$\tfrac{1}{2}\frac{du}{dx}=ex+dy+cz=0,$$

is the symmetrical determinant

$$\begin{vmatrix} a & f & e \\ f & b & d \\ e & d & c \end{vmatrix}.$$

The vanishing of this discriminant indicates that the conic $u=0$ breaks up into a pair of right lines, in other words possesses a double point.

From the properties of the resultant of a system of quantics [RESULTANT], we at once conclude that the discriminant of an m-ary n-ic, that is to say of a quantic of the n^{th} order in m variables, is a homogeneous function of the coefficients of the *degree* $m(n-1)^{m-1}$, and of the *weight* $n(n-1)^{m-1}$; it being understood that the coefficient of any term of the quantic is affected with a suffix equal to the exponent of the power of one of the variables x in that term.

Every equation with one unknown term may be converted into a binary quantic, and consequently has a discriminant. The latter, in fact, is the product of the squares of all the differences between any two roots of the equation, and consequently vanishes identically whenever the equation has two equal roots. The discriminant, it may be observed, lastly, is always an invariant of the quantic. [INVARIANT.]

Discus (Lat.). The ancient quoit, which consisted of a heavy circular mass of iron, sometimes perforated in the middle. In the ancient game, the players aimed at no mark, but simply tried to throw the quoit to the greatest possible distance. In the Cabinet des Antiquités of Paris, a discus is preserved in which holes are provided for the thumb and fingers. The practice of throwing discs is mentioned by Homer amongst the sports which occurred at the funeral of Patroclus; and Pindar celebrates Castor and Iolaus as skilful throwers of the disc.

Discutient (Lat. discutio, *I disperse*). Remedies which repel or resolve tumours.

Disease. Any morbid state of the body generally, or of any particular organ or part of the body, is called a *disease.* By medical writers the term *disease* is defined as implying 'a deviation from the natural and healthy actions of the whole system or of any individual part;' and they are in the habit of designating certain forms of disease by the following terms, namely: *Acquired*, which are not congenital or hereditary, but derived from causes evidently operating after birth. *Acute*, which are severe, but of comparatively short duration. *Asthenic*, attended by manifest depression of the vital powers. *Chronic*, which are of long duration. *Congenital*, which are born with the individual. *Constitutional*, which more or less affect the whole system. *Contagious*; this term should be confined to those diseases only which are communicable from one to another by *contact*, either personal or intermediate; it is presumed, for instance, that the plague is a truly contagious disease, and that it can be transferred from one individual to another only by actual bodily contact, or through the medium of bedclothes or articles of apparel. The term *contagious disease* is, however, often misapplied to those which are *infectious*, or communicable through the medium of the atmosphere. *Endemic*, diseases which are either peculiar to particular places, or which are especially prevalent in certain districts only. *Epidemic*, diseases which are generally diffused over a whole country; they may generally be traced to atmospheric causes, and are commonly of an infectious character: influenza and cholera often prevail in this way. *Exanthematous* are those diseases which are accompanied by an eruptive fever, such as measles, smallpox, &c. *Hereditary* diseases are such as prevail in families, and are transmitted by parents to their offspring; gout and scrofula furnish examples. *Idiopathic* or *primary* diseases are those which are not dependent upon or symptomatic of others; certain affections of the head, for instance, may arise immediately from disease of the brain, or they may be mediately connected with disordered states of the stomach: the former are idiopathic, the latter *symptomatic*. *Intercurrent* diseases are those which arise in individuals from incidental causes during the prevalence of endemic or epidemic sickness. *Intermittent* diseases are marked by a regular cessation and recurrence of symptoms; the patient, during the interval, being, to all appearance, free from disorder: the various forms of ague are characteristically intermittent. *Local* diseases are opposed to those which are constitutional; they are presumed to be limited to some particular organ: the term *chronic disease* is sometimes misapplied in this sense. *Malignant* diseases are those which are of a highly dangerous and intractable character.

and the symptoms of which are generally very formidable from the first; various forms of fever, rapidly depressing the vital energies, are said to assume a malignant type: hence also the term *malignant*, as generally applied to the Asiatic cholera. Local diseases are frequently malignant, such as cancer and ill-conditioned ulcers: all these are opposed to the *mild* forms of the same maladies. *Periodical*, diseases which recur at fixed periods, as in autumn, winter, &c. *Puerperal*, diseases incident to women soon after childbirth. *Specific* diseases are those which are marked by some disordered vital action not belonging to disease in general, but peculiar to the individual case. *Sporadic* diseases are those arising from adventitious causes affecting the individual. *Sthenic* diseases are marked by the activity of the vital powers, directly opposed to those which are asthenic.

Dr. William Farr some years ago proposed to apply the term *zymotic* to an extensive class of diseases which he probably regarded as produced by fermentation (from the Greek word (ζυμόω, *to ferment*). The term is perhaps more correctly applicable to diseases caused by paludal or animal decompositions, and in this way it has been used when speaking of fevers and of the effects of specific animal poisons. Its application has, however, been lately extended to diseases arising from scarcity of food, from unwholesome food, and even cases of scurvy and of worms.

Disfranchisement (Lat. dis; Teutonic, frank, *free*). The deprivation of the rights and privileges of free citizenship. The term is chiefly applied in the present day to the act which deprives a borough of the right of returning representatives to parliament.

Disinfectants. Substances which destroy infectious and contagious poisons. Many articles formerly considered as possessing these properties are now known to be ineffectual, such as the fumes of vinegar, of burnt resins, of aromatic woods, and certain essential oils; these, however, only cover bad odours. The real disinfectants comprise a few of the gaseous acids, but nearly all of these have been superseded by the peculiar powers of *chlorine*.

Disinfecting Liquor. Solutions of chloride of soda and of chloride of lime are known under this name. Labarraque's Disinfectant is a solution of hypochlorite of soda. Sir W. Burnett's Disinfectant is a solution of chloride of zinc.

Disintegration (Lat. dis, and integer, *whole*). The gradual wearing away of a rock by ordinary atmospheric action. All rocks are subject to this action, some wearing away evenly and regularly, and showing little sign of the change they undergo; others, such as granite, wearing very irregularly, owing to the unequal hardness of the rocks. Some of the Shetland Isles present magnificent specimens of the wear and tear of granite. On the west of Meikle Roe the softer veins have mouldered away, while the firmer rock which included them has remained unaltered; and in this way long narrow ravines are laid open which give access to the waves. The singular cluster of rocks at Hillswickness, which has been compared, when seen at a distance, to a small fleet of vessels with spread sails, also affords a good instance of granitic disintegration. Limestones sometimes disintegrate with great irregularity, but more frequently they form into caverns, the water eating them out. The disintegration of rocks by the seaside is very marked and often very instructive.

Hillswickness.

The action of weather is greatly helped when the climate is such as to admit of frequent alterations of temperature above and below the point at which water attains its greatest density (39° Fahr.). It is also well seen where ice is common in summer on account of the great elevation of the land. Thus, in mountains of great elevation this force is often exemplified.

Disjunctive. In Grammar, a conjunction which disjoins the sense of the connected sentences, as, 'He is either wicked or foolish,' 'They are neither wise nor brave.'

Disjunctive Proposition. In Logic, a proposition compounded of two or more categorical propositions, so stated as to imply that some of them must be true: thus, 'Either A = B, or C = D.' A disjunctive, in which the two propositions are not naturally connected together in such a manner as to warrant their being proposed as alternatives, is nugatory and absurd in sense, although not incorrect in logical form. If one or more of the categorical antecedent propositions be denied, we infer that the remaining one, or, if there are more than one, some one of those remaining, is true: e.g. 'Either A = B or C = D; but A is not equal to B, therefore C = D.' A poem is either good, bad, or indifferent: but it is not good; therefore it is bad or indifferent. There are different forms of the *disjunctive syllogism*, founded on the disjunctive proposition.

Disk (Gr. δίσκος). In Botany, a term applied to certain bodies or projections, situated between the base of the stamens and the base of the ovary, but forming part of neither, and taking a variety of forms, the most common of which are those of rings or scales. The disk is usually supposed to consist of rudimentary stamens, since an anther has been noticed to grow from that of *Pæonia Moutan*, and in other cases manifest indications are observable of a tendency to assume the form of those organs.

Dislocation (Lat. dis, and locus, *a place*). A surgical term, synonymous with *luxation*. 'When the articular surfaces of bones are forced out of their proper situation, they are said to be dislocated or luxated. A considerable share of anatomical knowledge is required to detect the nature of these accidents; and it is much to be lamented that students neglect to inform themselves sufficiently upon the subject.' (Sir A. Cooper's *Surgical Essays*, i. p. 2.)

Dispart. In Gunnery, half the difference between the diameter of the base ring at the breech of a gun and that of the swell of the muzzle.

Dispensary (Lat. dispensare, *to distribute*). A place where medicines are made up and distributed; but the term is used more generally for a charitable institution, where the poor are supplied with medicines and advice. Institutions of this nature are of comparatively recent origin; though they are now to be met with in every town of any importance both in this country and on the Continent. In London there are one or more dispensaries in each district; and to every dispensary there are always attached one or more physicians, surgeons, and apothecaries, whose duty it is respectively to prescribe and dispense medicines to the poor, and to visit them in their own houses in the event of their being too ill to attend personally at the institution. In most cases dispensaries are supported by voluntary contributions.

Dispensation. In Law, a license granted by the bishop to a clergyman within his diocese to omit some particular of his duty; as, to hold two or more benefices, or to reside out of his parish. In the church of England the power of dispensation has been very strictly limited by recent legislation. The name is peculiar to ecclesiastical law, and was formerly applied to the licenses granted by the papal authority for several purposes; as, to marry within the prohibited degrees, &c.

Dispensatory. A word synonymous with PHARMACOPŒIA [which see]; signifying a book which describes the history, preparation, and composition of medicines.

Dispensing Power. In English Law, it was held by early authorities, that the king had a right to *dispense* with the penalty on *mala prohibita*, things forbidden by law and not by moral obligation; whence the claims of James II. to *dispense* with tests against Roman Catholics and Dissenters, which contributed to his overthrow.

Dispersion (Lat. dispersio). In Optics, a term used to denote the angular separation of the constituent rays of light when decomposed by the prism. In consequence of the unequal refrangibility of the different rays, a beam of light admitted through a small hole or slit in the shutter of a darkened room, and refracted by passing through a prism, forms an elongated image or spectrum; the red rays, which are the least refracted, occupying one end of the spectrum, and the violet rays, which suffer the greatest refraction, occupying the other end. The rays therefore, after refraction, are no longer parallel; so that the *index* of refraction (or the ratio of the sine of incidence to the sine of refraction) is different for each ray; and the difference of the indices for the extreme rays is called the *dispersion* of the light.

Sir Isaac Newton, who first examined the prismatic colours, was led by some imperfect experiments to suppose the dispersion proportional to the refraction; but it was soon discovered that although the colours in spectra formed by prisms of different substances are always arranged in the same order, they do not occupy the same relative lengths—a prism of flint glass, for example, giving proportionally less red and more violet than a prism of crown glass; and that substances, for which the index of refraction of the middle ray of the spectrum is nearly the same, produce spectra of different lengths, or different amounts of dispersion. It is on this property, namely, the irrationality of the refractive and dispersive powers of different substances, that the methods of forming achromatic lenses depend: had the supposition of Newton been correct, it would have been impossible to produce an image by refraction unaccompanied by the prismatic colours. [ACHROMATISM; OBJECT-GLASS.]

The difference between the indices of refraction of the extreme rays of the spectrum formed by a prism of any substance is called the *coefficient of dispersion* with respect to that substance, or simply the *dispersion*; and the *dispersive power* is the quotient which is obtained by dividing the coefficient of dispersion by the mean index of refraction diminished by unity. The *mean index* is that of the ray which corresponds to the middle of the spectrum. As these terms are of frequent occurrence in scientific works, we shall illustrate the definitions by an example. According to Sir D. Brewster, the index of refraction of diamond for the extreme violet ray is 2·467, and for the extreme red ray 2·411; the difference of these two indices is ·056, which, therefore, is the coefficient of dispersion for diamond. Again, the mean index, or mean of the above two numbers, is 2 439, which diminished by unity becomes 1·439; therefore the dispersive power of diamond is ·056 divided by 1·439, or ·0388. [REFRACTION; LIGHT; OPTICS; SPECTRUM.]

Displacement of a Vessel. The weight of water which a vessel displaces, which is of course equal to her own weight; the shipwright's or government measurement ought to furnish a very good approximation to the quantity thus ascertained, but they both are made to comprehend so many extraneous conditions that they afford very slight indications of the actual displacement.

Disposition. In Architecture, one of the six essentials of the art. It is the arrangement of the whole design by means of the ichnography (plan), orthography (section and elevation), and scenography (perspective view); and dif-

fers from *distribution*, which signifies the particular arrangements of the internal parts of a building.

Dissection (Lat. disseco, *I cut asunder*). The cutting to pieces of any organised body with a view to elucidate its structure and functions. [Anatomy.]

Disseisin. In Law, a species of wrongful ouster or putting out of him who is seised of the freehold in lands: it is either *single disseisin*, or *disseisin by force*, more properly termed *deforcement*.

Dissenters. Persons who dissent from the doctrines or usages of the established church of England. Roman Catholics, however, are generally referred to as a distinct class, and the term Dissenters applied to Protestants only.

The first dissenters from the church of England were the Puritans, who, at the beginning of the reign of Elizabeth, complained of the use of the surplice, the sign of the cross in baptism, and some other relics, as they esteemed them, of popery. The laws of Elizabeth, however, required their attendance at church under severe penalties; and no opportunity was allowed them, even though they held episcopacy itself in abhorrence, of forming separate sects or congregations. Perhaps the first distinct sect of Dissenters were the Brownists, who adopted very extreme opinions on the subject of church government, and against whom the punishment of death was enacted, as denying the queen's supremacy in ecclesiastical matters. On the accession of James I. an attempt was made by the puritanical party within the church to obtain a relaxation in some points of doctrine and discipline; but the conference at Hampton Court, which was convened upon that occasion, separated without effecting more than a few trifling alterations in the services. The penal laws continued in force, and Dissenters were not recognised as a distinct body by the state. They may be said to owe their origin in this sense to the assembly of divines convened by authority of parliament at Westminster in 1643, when a body of 120 clergymen and 30 laymen met and established the Presbyterian forms of doctrine and government, as set forth in the book called the *Directory*. The Independent party did not entirely accede to this settlement, and created some disturbances during the Protectorate. At the Restoration, the Presbyterian clergy were ejected on St. Bartholomew's day, 1662, by the Act of Uniformity, which re-established the Liturgy, and was attended with some circumstances of aggravation and harshness. Two thousand nonconforming clergy were thereby ejected from their benefices. The Corporation Act, requiring attendance on the sacrament preparatory to accepting municipal offices, was also passed at the beginning of this reign; and the Test Act followed, which excluded Dissenters in like manner from all places of trust and profit under government. These laws were repealed by 9 Geo. IV.; and Dissenters are now required only to make a declaration, according to the form of the Act, that they will not exercise any influence they may possess by virtue of such office to injure or weaken the church by law established. The Act of Toleration (1 Wm. & Mary) had long since abrogated the penal laws of Elizabeth against Dissenters, excepting Papists and such as deny the Trinity.

Dissepiments (Lat. dissepimentum). In Botany, the partitions that are formed in the ovary by the united sides of the cohering carpels, and which separate the inside into cells; also called *septa*.

Dissidents. In modern European History, a term applied in Poland to those dissenters from the established religion (Catholic) who, under the old republic, were allowed the free exercise of their faith; including Lutherans, Calvinists, and Greeks, but excluding various minor sects. Their rights were fixed by the Religious Peace (pax dissidentium) of 1573, but they were infringed upon in the eighteenth century by various princes. They were supported in demanding the repeal of these restrictions by Russia and Prussia (in 1766), and hence those powers acquired one of their favourite pretexts for interference in the affairs of the Polish nation. Their rights were restored in 1775, with some exceptions; but after the Russian conquest they were placed on the same footing with the Catholics.

Dissolving Views. These popular phantasmagorial representations are produced by means of two magic lanterns [Magic Lantern], which are placed side by side with their lens tubes slightly convergent, so that the projected images may be superposed upon the screen placed to receive them. An opaque rectangular shutter, capable of revolving vertically upon a pivot fixed midway between the two lanterns, is placed in front of the enses in such a position that, when horizontal, it cuts off one half of the pencil of light from both lenses. If this shutter be made to revolve through a small arc, it must obviously shut off the whole of the pencil of light from one of the lanterns which we will call A, whilst it allows that from the other lantern B to pass unhindered. When the shutter is in this position, and each lantern is supplied with its slide, the image from B will be seen upon the screen in full brilliancy; but if the shutter be now made slowly to revolve in the opposite direction, the image from A will be gradually disclosed and that from B in the same degree concealed; the one appearing to dissolve whilst the other developes. To obtain a good effect with this apparatus, it is necessary that the lanterns should be illuminated with the lime light.

Dissonance. In Music, the same as *discord*.

Distemper. A disease of the dog. The distemper in dogs is commonly considered as a catarrhal disorder, and in general a running from the nose and eyes is one of the first and leading symptoms; it is usually accompanied by a short dry cough, and succeeded by wasting of the flesh and loss of strength and spirits.

The nasal defluxion, which is at first watery, becomes after some days, or perhaps weeks, mucous and purulent, loading the eyes and obstructing the nostrils; the cough becomes more distressing, and is attended by an effort compounded of coughing and vomiting; the listlessness, wasting, and loss of appetite also increase.

If the disease be virulent, symptoms of affection of the brain are its frequent concomitants, attended by fits, and great debility and paralysis of the extremities, or by convulsive twitchings resembling St. Vitus's dance; and such is the induced irritability of the animal at this period, that an angry menace or the sight of another dog will often bring a fit on, while fondling and encouraging a dog under these primary attacks will shorten their duration or altogether check them. If they continue, and increase in violence and frequency, they commonly prove fatal. 'If the fits,' says Mr. Blaine, 'have gained their full hold on the dog, a partial or total mental alienation takes place; when total, the poor animal is often perfectly phrenitic; he waters and dungs unconsciously; he tears up the ground, bites everything around him, and not unfrequently himself also. When the fit is over, he shakes himself, and looks and acts as usual, unless the attacks have been very violent and long-continued, when they leave him greatly exhausted and dispirited.' In some of these attacks the dog walks round and round, unconscious of everything about him. In such cases, the unfortunate animal is often supposed to be mad, and is frequently sacrificed accordingly; 'but the suddenness of the seizure ought to inform the looker-on of the total impossibility of its being *rabies*, which is always in the worst cases marked with some recollection, some knowledge, and which never exhibits the indiscriminate fury which characterises epilepsy.'

Inflammation of the lungs is by no means an unfrequent consequence of distemper; and the bowels are always more or less affected by diarrhœa and dysenteric discharges, often indicating ulceration of the intestinal canal, and accompanied by bloody mucus and extremely offensive evacuations.

Protracted cases of distemper are sometimes attended by a pustular eruption on the abdomen and chest, accompanied sometimes by an hepatic affection, called by sportsmen the *yellow disease*, from its giving the whole surface of the body a yellow hue: these are almost always fatal symptoms.

The danger and fatality of this disease depend upon so many causes, that it is extremely difficult to prognosticate the results: it is frequently fatal to weakly and delicate dogs, and more so in town than in the country. Early in the disease a single fit is not alarming; but one or more fits in the advanced stages are seldom followed by recovery: impatience of light, red eyes, pneumonic attacks, and obstinate diarrhœa, are all bad symptoms; and spasmodic twitchings, a yellow tinge of the skin, and a pustular eruption, are in almost all cases the forerunners of death.

Laxatives, emetics, and occasional bleeding, are the leading remedies in the early stage of this disease; obstinate diarrhœa should be checked by astringents; and warm bathing and antispasmodics must be resorted to to quell the violence of the fits.

The distemper is communicated by the contact of the diseased catarrhal secretion, and it may also be given by its inoculation; inoculation has indeed been proposed as a mitigation of the disorder, and it has been asserted that vaccination is a preventive. But it has been proved by Mr. Blaine that vaccination is quite inefficacious; and that inoculation with the matter of distemper is equally inefficient in mitigating the complaint, even when it is borrowed from the mildest forms. Many dogs, indeed, which have taken the disease by inoculation have had it with peculiar severity, and several have sunk under it. (Blaine's *Canine Pathology*.)

Distemper or **Destemper** (Fr. détrempe, Ital. tempera). In Painting, a preparation of opaque colour ground up with size and water, with gum-water, or similar vehicles. It is used especially in scene painting. This species of painting is also called, when practised on a small scale, *body-colour painting*, *tempera*, and *gouache*, from the Italian guazzo. Distemper or tempera was the ordinary method of painting in the higher departments of art, as well as illuminating, before the establishment of oil or varnish painting; many remarkable specimens of early Italian, Flemish, and German pictures of this class are in the National Gallery. The method is generally objectionable, the rapidity with which the vehicle dries rendering it difficult to blend the tints. This objection was in a great measure obviated by the Cologne and early English painters, by mixing a small quantity of honey with their *tempera*, which rendered it less drying. Egg and fig-sap have also been similarly employed: both were used by the ancients. But this method of painting has been generally superseded in Europe, for higher art, by the method of varnish painting established by the Van Eycks early in the fifteenth century. (Eastlake's *Materials for a History of Oil Painting*, 1847.) [Oil Painting.]

Disthene (Gr. δίς, and σθένος, *strength*). A name given by Haüy to Kyanite, in consequence of its double electric powers; some crystals becoming negatively, and others positively electric by friction.

Distich (Gr. δίστιχος). A couplet of verses. In the Greek, Latin, and German languages, this term is applied to pieces of poetry consisting of two lines, in hexameter and pentameter verse.

Distichiasis (Gr. δίς, and στίχος, *a row*). A double row of eyelashes, the innermost of which excite a constant irritation of the eye. The term *trichiasis* is generally applied to this malformation.

Distichous (Gr. δίστιχος). In Botany, a term applied to the arrangement of organs in two rows, the one opposite to the other, as the florets of many grasses.

Distillation (Lat. distillatio). The evaporation and subsequent condensation of liquids by means of a *still* and *refrigeratory*, or of a *retort* and *receiver*.

The discovery of the art of distillation is generally ascribed to the alchemists; but it was doubtlessly known in more remote ages to the Arabians, and by them probably derived from nations farther east.

The process of distillation, though in continual use in the chemical and pharmaceutical laboratory, is carried on upon the most extensive scale for the production of ardent spirits in the *distilleries*. Under the words ALCOHOL, BRANDY, FERMENTATION, WINE, &c. will be found some details bearing upon the nature, sources, and production of spirituous liquors; in the present article, therefore, we shall limit ourselves to an outline of the different processes which are more exclusively conducted in the British distillery.

There are two distinct operations in the production of ardent spirits: the one is the conversion of certain vegetable principles into alcohol; and the other, the separation of the alcohol from the other substances with which it is necessarily blended during its production.

The vegetable principle which is essential to the formation of alcohol is *sugar*; and this is sometimes used *directly*, as where molasses and analogous saccharine products are subjected to immediate fermentation; or it is *indirectly* obtained by subjecting amylaceous grains to certain processes, by which the starch they contain is first converted into sugar, and then that sugar afterwards alcoholised.

In our distilleries the latter alternative is adopted; and various kinds of grain, but chiefly barley, wheat, and rye, with more or less malt, are subjected to the operation of *mashing*. For this purpose the ground grain and the bruised malt are duly mixed, and infused under constant agitation in a proper quantity of hot water in the *mashtun*; the wort is then run off, and fresh water added, till the soluble materials of the grain are extracted.

In this way the mixed worts or *wash* is obtained, which is afterwards to be subjected to fermentation; but in the distillery the operator is not, as in the brewery, left to his own judgment or convenience, but enforced to conform to the excise laws, which are of a very peremptory character. By these laws the distiller is restricted in the density of his worts to specific gravities between 1050 and 1090; and in Scotland, between 1030 and 1075. It is presumed that at those specific gravities, which are called 50 and 90, and 30 and 75, the actual quantity of saccharine or sacchariflable matter contained in each barrel (or 36 imperial gallons) amounts respectively to from $47\frac{1}{4}$ lbs. to 85 lbs., and from 28 lbs. to $79\frac{3}{10}$lbs. When this wash is adjusted as to density, it is run into the fermenting vats, where, mixed with a small quantity of yeast, it is subjected to the process of fermentation, which continues from six to ten or twelve days, the time required for its completion varying with the mass of liquid and with the temperature of the atmosphere.

During mashing, the starch passes into sugar, and during fermentation the sugar changes into alcohol; the consequence of which is that the wash gradually decreases in density or *attenuates*; and as soon as this attenuation has reached its maximum, which may be determined by the hydrometer, it should be distilled in order to prevent the commencement of acetic fermentation.

In all large distilleries there are two sets of stills: one for the purpose of distilling from the wash a weak spirit, technically called *low wines*; and the other for redistilling (or *rectifying*) the low wines. In these distillations there passes over along with the first and last portions of the spirits a peculiar volatile oil of a disagreeable flavour and odour, and rendering the weaker spirit milky. These portions are called *faints*, and are carefully turned into separate receivers as soon as the appearance of the runnings from the worm end indicates their presence.

The stills now universally employed are those invented by Mr. Eneas Coffey of Dublin. In this apparatus, technically known as *Coffey's still*, the spirituous vapour is condensed by the cold wash, which is thus gradually heated nearly to its boiling point, saving thereby a large amount of fuel. These stills can produce as much as 3,000 gallons per hour.

The quantity of alcohol which may be obtained from a given quantity of sugar will depend upon the skill and care with which mashing, fermentation, and distillation have been respectively conducted; theoretically, 100 pounds of sugar are convertible into about 51 of alcohol and 49 of carbonic acid. The quantity of alcohol to be procured from different kinds of grain will also depend upon the same causes, and upon the quantity of sugar, and of starch and gum convertible into sugar, which each may contain. According to Hermstædt, 100 pounds of starch should yield 35 pounds of real alcohol; and 100 pounds of the following grains should yield the following quantities of spirit of the specific gravity of 0·9427; that is, of spirit containing 45 per cent. of real alcohol; namely, wheat 40 to 45 pounds, rye 36 to 42, barley 40, oats 36, buckwheat 40, maize 40.

Sometimes, though rarely, malt only is used in the distillery, in which case the distiller calculates on obtaining two gallons of whisky of proof strength from each bushel of malt.

The *proof spirit* of commerce, and that of the Pharmacopœia, is generally stated to be of the specific gravity of 0·920 at 62°, and is considered as a mixture of *equal weights of absolute alcohol of the specific gravity of* 0·791 *at* 60°, *and of water*. The *rectified spirit* of commerce, or rather that of the Pharmacopœia, is directed

to be of the specific gravity of 0·838 at 60°, and may be regarded as a mixture of about 82 parts of absolute alcohol and 18 of water. [SPIRITS.]

Distoma (Gr. δίστομος, *double-mouthed*). The name of a genus of Trematode intestinal worms, including those which have two suckers or organs of adhesion, of which the anterior alone is a true mouth; and the posterior or larger disc is situated on the ventral aspect of the body, a little way behind the mouth.

Distortion (Lat. distortio). An unnatural deviation of shape or position of any part of the body, producing visible deformity.

Some distortions are exclusively dependent upon disordered actions of the muscles or nerves, or both; certain kinds of lameness, for instance, arise from a want of due sympathy between the flexor and extensor muscles, or from an unnatural contraction of one or more muscles in consequence of the inefficiency of their opponents; hence various paralytic distortions, squinting, wry neck, and some forms of what is termed *club-foot*.

The most common cause of distortion, however, is disease of the bones, which, being sometimes deficient in their hardening or earthy principle, are incapable of supporting the weight of parts which they are designed to bear, or of sustaining pressure or muscular action, without more or less flexure. Of this kind is the disease called *rickets*, in which it has been presumed, though erroneously, that the vertebræ are the chief seat of the mischief. Besides rickets, there are other cases of curvature of the spine, the causes of which are by no means very obvious, more especially those of the *serpentine* or *lateral* curvature, which is not unfrequent among delicate girls in the higher and middling classes of life, though of very rare occurrence among the lower orders. This disease is usually observed about the ninth or tenth year, and the symptoms are generally traced in the following order: 1. The child makes frequent attempts to prevent the dress falling off one shoulder; 2. One shoulder appears higher than the other; 3. One of the collar-bones, or one side of the breast-bone, appears fuller than the other; 4. One hip appears to project; 5. One leg appears shorter than the other; 6. There is a peculiarity in the manner of walking, one foot being swung round and the shoulder thrown forward. When the girl reaches the age of twelve or thirteen (for this disease is *very rare* in boys), she becomes evidently twisted, and the spine is found to have assumed a serpentine form. In reference to the treatment of this kind of distortion, it appears that very opposite methods have been successful; thus, some patients have been confined for months to the same position; another violently exercised; another shampooed and acupuncturated; a fourth relies on artificial supports, such as stays and bandages; a fifth is leeched or blistered; and many are told to attend only to the general health. The truth is, that distortion may depend upon different causes, and different remedies may be required in its different stages of progress. The serpentine curvature of the spine generally originates in muscular debility; and therefore, at its commencement, is appropriately treated by attention to the general health, by proper exercises and tonics. As the disease, however, proceeds, the muscles and ligaments acquire a certain form, and then artificial supports may be appropriately resorted to. In a yet more advanced stage, the vertebræ themselves become altered in form; and hence the spine may require to be stretched, and kept so during a considerable part of the twenty-four hours, so as to allow the bones to resume their natural form. When the ribs and sternum have become much displaced and misshapen, methods of compressing and remodelling them must be adopted; and lastly, when what is called *anchylosis*, or permanent bony deformity, has taken place, palliations and preventives of further mischief can alone be resorted to.

In all cases where there is a tendency to distortion, its early progress should be watched with the utmost solicitude, and *preventive means* steadily and perseveringly adopted. When a girl is eight or ten years old, she should not be confined to the schoolroom, and to a walk once or twice a day, but she should be induced by amusing and romping games to use active exercise, and especially such as brings the muscles of the trunk into play; she should not be kept long at the pianoforte, and her chair should be made so as to support her. If she has a tendency to lean to one side, she should be allowed to learn her lessons in a recumbent posture, and not constantly admonished to 'hold herself up.' By attention to these simple rules at a very early period of this tendency to distortion, its farther progress may be possibly prevented; but if the girl becomes listless, lounging, pallid, and awkward in her gait, the spine is probably becoming distorted; and in this case she should not be allowed to sit erect without using some artificial support, such as an arm-chair, or chair crutch, and she should read always lying down; while by the help of proper stays and a belt support should be given to the loins, the upper part of the chest being left free. No shoulder-straps, collars, or back-boards should be used to push in the projecting shoulder, unless the loins be at the same time supported; for in the majority of cases a sinking of the lumbar part is the cause of the inequality of the shoulders. The child should, in this stage of the disorder, be a good deal in the open air; not walking sedately, but, if possible, skipping about; and when she comes in, should not lounge on a chair, but lie down; or if out-of-door exercise be inadmissible, she should play at battledore and shuttlecock, and use a skipping rope. But whatever exercise be used, it should never be carried to fatigue. The child should sleep on a firm hair mattress, with scarcely any pillow; she should have good nourishing diet; occasional warm aperients and alkaline tonics may be proper, with cold bathing or sponging. By scrupulously following up the preceding plan,

the general health is improved, and the tendency to distortion often diminished; but constant care for months, and even years, can alone insure its removal. Where the spine has acquired a decided twist, a variety of mechanical contrivances, and many different plans of treatment, have been proposed and used with more or less success.

There is another kind of distortion, differing entirely from the preceding; namely, *angular curvature* of the spine. It generally proceeds from scrofulous ulceration of the bodies of the vertebræ; it is attended with paralysis of the lower extremities, and is often fatal. Similar disease often occurs in the other bones and joints of the body.

There are a variety of deformities resulting from other causes than those above adverted to; namely, from gout, rheumatism, and various chronic and local affections, which, however, do not come under the general term of *distortions*: nor can we properly refer to this head a variety of real deformities which are chiefly the consequence of dress and fashion; such as those which result from wearing stays, bandages, ill-made and tight shoes, and the like.

Distractile (Lat. distraho, *I draw apart*). In Botany, a term invented by Richard to denote a connective which divides into two unequal portions, one of which supports a cell and the other not, as in *Salvia*.

Distress. In Law, the taking of a personal chattel out of the possession of a wrongdoer into the custody of the party injured, to procure satisfaction for the wrong committed.

Distress may be had for various kinds of injuries, and as a means of enforcing process, or the performance of certain acts in various cases. But the most usual injury for which a distress may be taken is that of non-payment of rent. Distress for rent is said to be incident to the reversion; so that it may be taken for rent reserved upon a gift in tail, lease for life, years, &c., though there be no clause of distress in the deed, if the reversion is in the party distraining. It cannot, however, be taken for arrears of rent older than six years (3 & 4 Wm. IV. c. 27). Distresses are to be of things valuable, wherein some one has a property. But various species of personal chattels are exempt from distress, especially the utensils and instruments of a person's trade and profession, if in actual use; otherwise they are not privileged. *Excessive* distress, that is, unreasonably great, was rendered illegal as long ago as 52 Hen. III. by the statute of Marlbridge, which gave a special remedy to the sufferer. All distresses for rent must be made by day, and on the premises; but if any tenant fraudulently removes goods from off the premises, the landlord may within thirty days seize such goods wheresoever found, unless they are sold for a valuable consideration before the seizure. Persons who distrain for rent may sell the distress for payment of rent in arrear, if the tenant or owner fails to replevy, with sufficient security, within five days after taking the distress and giving the tenant notice of the cause. In this case the constable is bound to assist; the goods are to be appraised by two sworn appraisers; and the overplus, if any, left in the constable's hand for the use of the owner.

Distribution. In Political Economy, this term is used in two senses. In the former, it denotes the act by which the larger transactions of production and carriage are supplemented by the operation of certain agents, who bring commodities, by small parcels, within reach of the consumer's demand. In the growth of society, and in the freedom which economical science indicates as furnishing the best means by which individuals may employ their several faculties and opportunities for their own advantage, the tendency is always towards multiplying as far as is necessary all such intermediaries; the division of such occupations, just as in other kinds of labour, being determined by the 'width of the market.' In other words, when societies are large, there is always a disposition towards a separation of employments; caused by the fact, that larger profit to the individual, and by implication greater benefit to mankind, comes from undivided attention to one particular calling. In small societies, on the other hand, the same person undertakes to meet a multitude of wants, and can, therefore, offer neither the same intelligence in procuring nor the same variety in supplying as are achieved by the division of occupation. If all action be free, the number of persons intermediate to production and consumption is governed solely by the general advantage of society. This sense of distribution depends on reciprocity of services.

The other sense of *distribution* refers to the division of products. The gross amount of all labour is divided among the community; each individual, if a fair apportionment based on services rendered is effected, receiving his just share of the whole quantity. One man supplies muscular labour, another capital, a third supervision, a fourth protective, administrative, legal or military, a fifth education, and so on. In proportion to his contribution to the value of the produce, each receives, or should receive, his portion of the whole, the laws of society tending generally towards a just appraisement of the service rendered, by the operation of competition, of supply and demand, and of individual values.

This view of the term *distribution* is fundamental, and of the greatest significance in Political Economy. It must be understood in order to apprehend and interpret the bearings of the economical principles of Population, Law, and Taxation.

1. It is connected with theories of Population, because when population is in excess, or, in other words, when the supply of labour exceeds the demand, or the employment for it, the amount distributed to each individual from the fund of capital destined for wages is, in degree, less; and, on the other hand, when the supply of labour is scanty, the amount

received in wages is, conversely, more. It will be impossible that more should be given than the gross amount receivable by labour; and hence any attempt to regulate the wages of labour with a view to increasing the amount, will end in a mere diversion of part of the wages which one labourer should receive into the hands of another. [POPULATION; TRADES UNIONS.] Similarly, if profit is to be derived from capital, it will be impossible to lower wages when labour is insufficient for demand.

2. It is connected with Law, in so far as law determines the possession of land, or attempts to regulate price. In this country, where the rule of primogeniture prevails, and the privilege of strict settlement—that is, the power of continually creating a contingent estate in favour of non-existent persons—is permitted, the question as to whether such a system is beneficial or mischievous is constantly agitated. Hence it is that most English treatises on Political Economy are largely occupied with dissertations on rent, on forms of tenancy, and on the comparative advantages of the ordinary farming system and of actual ownership. Although, of course, the real question at the bottom of all disquisitions on the prevailing tenure of land in countries is political, and therefore wholly alien from any scientific consideration, the subordinate question of its economical effect is the legitimate province of the economist. [RENT; PEASANT PROPRIETOR; METAYER; RYOT.]

Legislatures have at all times attempted to regulate prices. It seems so natural to think that authority can decide tastes, or check habits, or give advantages, or secure a form of policy, and the countervailing forces to such enactments are, for obvious reasons, so obscure, that it is not wonderful that legislative action should have been invoked to confirm such supposed benefits. The attempts have always been failures. It is impossible to coerce natural laws. If legislative regulations are unwise, and can be evaded, they are evaded; if they are unwise, and cannot be evaded, they invariably inflict first a loss on the public, next a loss on the favoured object. If they are wise, they are as superfluous and supererogatory as it would be to pass a law in order to give effect to the solar system. [PROTECTION.]

3. It is connected with Taxation in so far as the incidence of taxation is just. Every man derives, or should derive, advantage from the administration of government, and should contribute proportionately, in consideration not only of the service which he receives from the public, but of that which he renders to the public. Hence the question of what he receives is of the greatest meaning in finance, if indeed finance is to be anything more than a raid on the weak and unprotected; and, of course, as money is only the measure of value, and the only true values are mutual services, it follows that each man's proportion is not what he takes in money, but what he gets in money's worth. Hence if we could prove statistically that the income of labourers (in the popular sense) receiving 100*l.* a year and the income of all above this condition were equal, and both incomes were taxed at equal rates, it would still be a question whether the purchasing power of the former is equal to that of the latter, and therefore whether the distribution of taxation is just. [MONEY; TAXATION.]

DISTRIBUTION. In Printing, the replacing of the types in their respective boxes in the cases, after being printed off, preparatory to their being set up again. [COMPOSITION.] A handful of the types is wetted, and held in the left hand. The types are then thrown letter by letter into the case with the forefinger and thumb of the right. The freedom from error in proofs depends mainly on *clean* distribution.

District (Lat. districtus, part. of distringo. *I sunder*). A territorial division. This term was formerly used in France, and particularly in the year 1790, when, by the law of February 16, the whole country was divided into 555 districts; and it is still common to many of the Continental states. The county of Lincoln is divided into three districts: Lindsey, Kesteven, and Holland. These divisions are of great antiquity, and in all probability owe their origin to the distinct natural features by which they are characterised.

Distringas. In Law, a writ addressed to the sheriff commanding him to distrain goods [DISTRESS] in several cases, of which the most usual was formerly to compel an appearance. It is now abolished by the amendment of process (1852). In Equity, a distringas is issued to compel appearance by a corporation aggregate: and it is also issued for the purpose of preventing the transfer of stock or payment of dividends by the bank of England, at the suit of a party claiming to be interested therein, under 5 Vict. c. 5.

Ditch or **Fosse.** In Fortification, the excavation round the work, serving as an obstacle to the enemy, and supplying earth for the parapet.

Dithionic Acid (Gr. δίς, and θεῖον, *sulphur*). Berzelius applies this term to the *hyposulphuric acid*; and he calls the hyposulphurous acid, *dithionous*. The term implies the existence of *two* atoms of sulphur in each of these acids.

Dithyrambic Ode (Gr. διθύραμβος). A species of Greek lyrical poem in honour of Bacchus, which derived its name from Dithyrambus (Διθύραμβος), one of the appellations of that deity: a word of uncertain meaning and etymology. The style of this poetry was very bold, often passing into bombast; so much so indeed as to become proverbial for the latter quality. In modern times the term is indiscriminately employed to designate odes of an impetuous and irregular character. [ODE.]

Ditone (Gr. δίτονος). In Music, an interval consisting of two tones.

Ditriglyph. In Architecture, an arrangement of the intercolumniations in the Doric order, by which two triglyphs are obtained in

the frieze between the triglyphs that stand over the columns.

Ditto (Ital. detto, *the said*). In Bookkeeping, more usually contracted into *Do*, signifies *the same* as that which precedes it.

Diuresis (Gr. διούρησις, *a discharge of urine*). An excessive flow of urine. [Diabetes.]

Diuretic. This term signifies literally anything which increases the secretion of urine. It is usually applied to certain medicines which act specially upon the kidneys, such as squills, turpentine, and some of the neutral salts; and it frequently happens that during an inordinate flow of urine derived from such causes watery fluids are absorbed from other parts, and, as it were, transposed to the kidneys: upon this principle is founded the use of diuretics in dropsy. There are some alteratives which operate as diuretics, especially when they are taking a favourable operation upon the system: this seems especially to be the case with sarsaparilla. Water and other diluents and liquids, when taken in excess, also operate as diuretics; as far, at least, as mere increase in the flow of urine is concerned.

Diurnal (Lat. diurnus, from dies, *a day*). The name given to the book containing those canonical hours of the Roman Catholic breviary which are to be said during the day. It is intended especially for the clergy of the Romish church, and consists generally of four volumes, one for each season of the year.

Diurnals (Lat. diurnus). A tribe of Raptorial birds, including those which fly by day and have lateral eyes: also a family of Lepidopterous insects, which have a similar period of activity.

Divan. A word common to many of the Eastern languages, signifying in Turkish the audience-chamber of the vizier, or supreme judicial tribunal. The divan of the caliphs was a court for the relief of petitioners, over which those monarchs presided in person. The Turkish divan, as is well known, is the great council of the empire.

It would seem that the earliest acceptation in which this word was employed is that of a muster-roll or military day-book; and we find it used, especially by the ancient Arabs, who borrowed it from the Persians, to signify a collection of poems by one and the same author, arranged in alphabetical order; thus we hear of the Divan (i. e. the collected poems) of Sadi, the Divan of Hafiz, &c. The word *divan* is also among the Turks a common appellation for a saloon or hall which serves for the reception of company, for the transacting of business, or for occasional repose; hence in common the use of the term to signify a sofa.

Divaricate (Lat. divarico, *I stretch asunder*). In Botany, spreading abruptly at an obtuse angle.

Divaricate. In Zoology, when the divisions of a part spread out widely.

Divergent (Lat. dis, and vergo, *I incline*). In Zoology, when the branches form a right angle with the stem; as the snags of certain antlers, the divisions of certain Polypiaries, &c.

Divergent Series. [Convergent and Divergent Series.]

Diverging. In Botany, used in describing the venation of leaves, to denote the angle which is formed by the midrib and one of the primary veins, when it is between 20° and 40°.

Dividend (Lat. dividendus, *to be divided*). In Arithmetic, the number or quantity given to be divided. Dividend, in Commerce, is the name given to the payment made to creditors out of the estate of a bankrupt, and to the annual interest payable upon the national debt and other public funds.

Divination (Lat. divinatio). The art of foretelling future events. At an early time divination formed a regular science, intimately allied to religion, and furnished with rules and regulations. Of all the nations of antiquity, few cultivated the science of divination with such enthusiasm as the Greeks and Romans. Under the different heads, as Belomancy, Necromancy, &c., the reader will find a notice of the principal methods of divination; and for the rest he may consult with advantage Cicero *De Divinatione*. [Oracle.]

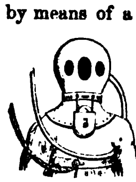
Divine Right of Kings, the. In Politics, means the absolute and unqualified claim of sovereigns on the obedience of the people; insomuch that, although they may themselves submit to restrictions on their authority, yet subjects endeavouring to enforce those restrictions by resistance to their unlawful acts are guilty of a sin. This doctrine, so celebrated in English constitutional history, has been asserted on very different grounds. Hobbes (*De Civ.*) deduced the absolute authority of kings from the supposed social contract, whereby men parted absolutely with their natural rights in exchange for protection. But the fashionable political writers and theologians of the times both of Charles I. and Charles II. (in the latter reign, Sir Robert Filmer, author of the *Patriarcha*, may be more especially cited, on account of his having been directly answered by Leslie) maintained that government had an existence before property, and before any supposed social contract could take place; that it originated in the patriarchal sway, which was succeeded by the regal, and that no other was authorised by Scripture. See also the *Convocation Book* of 1603; Archbishop Leslie on the *Power of the Prince*; Sherlock's *Case of Resistance to Supreme Powers*, 1684; Mackenzie's *Jus Regium*, 1683. The same principles were practically adopted by the Jacobites, when they maintained the divine right of the expelled sovereign, and afterwards of his descendants, by hereditary title. As to the views of modern high-church divines on the subject, see Dr. Pusey's *Sermon on the 5th of November*, 1837. [Non-resistance.]

Diving (another form of *dip*; Dutch, duypen). The art of descending in water. Independently of the valuable native productions which are found at the bottom of the sea, such

as pearls, coral, sponges, &c., the treasure which is so frequently carried down in wrecked vessels makes it an object of importance to be able to descend to the bottom and remain there long enough to execute the operations necessary to recover it. But without the assistance of some mechanical apparatus, even the most practised divers can do very little. A minute and a half, or two minutes, is the longest time that a diver, in general, can remain under water. Besides, on account of the loss of weight in water, the power which a man can exert is extremely small, unless borne down by a load which would entirely prevent him from rising again to the top.

The diving helmet and the diving bell [Diving Bell] are the apparatus employed in operations requiring prolonged submersion.

The diving helmet is made of thin sheet copper, which covers the head of the diver, large enough to admit of free motion, and furnished with three eye-holes, covered with glass protected by brass wires. The helmet comes pretty well down over the breast and back, and is fastened by rivets to a waterproof canvas jacket so tightly that no water can penetrate. A leather belt passes round the diver, to which are attached two weights, one before and the other behind, each about 40 lbs. The belt is supplied with a buckle in front, which, in case of any accident happening, can be instantly undone. The diver is supplied with fresh air by means of a flexible waterproof pipe, which enters the helmet, and communicates with an air-pump, worked above in the barge from which he descends. This pipe passes under the left arm of the diver, and enters the back of the helmet, being so contrived that the fresh air is made to impinge on the glasses; which in a great measure prevents their being dimmed by the moisture of the breath. From the back part of the helmet there is also led an eduction pipe, to allow the escape of the breathed air. A signal line passes under the right arm to communicate with attendants at the surface. The diver descends from the side of the vessel, either by means of a rope or wooden ladder, loaded at the lower end, the weight being kept at a little height above the ground. When the diver descends to the bottom, the weight is let down, and the rope allowed to become slack, to prevent the motion of the boat from obstructing him. His motion is rendered steady by heavy weights attached to his feet; and he carries a line in his hand, that he may, when necessary, guide himself back to the rope. A waterproof dress covers his body entirely; and he is thus enabled to remain under water five or six hours at once, all the while perfectly dry.



Diving Bell. An apparatus by means of which persons are let down and enabled to remain under water, and execute various operations; such as levelling or clearing the bottoms of harbours, preparing a foundation for buildings, bringing up sunken materials, &c. The principle of the diving bell depends on the impenetrability of atmospheric air, and may be illustrated by a very familiar experiment. Bring the edge of an inverted tumbler, or any close vessel, to the surface of water, and, keeping the mouth horizontal, press it down in the water. It will be seen that, though some portion of water ascends into the tumbler, the greater part of the space remains empty, or only filled with air; and any object placed in this space, though surrounded on all sides with water, would remain perfectly dry. In fact, the quantity of air remains the same, but is compressed into a smaller volume, in proportion to the depth to which it is made to descend. Now, if we conceive a vessel of wood or iron, sufficiently capacious to hold several men, to be suspended by a chain, and lowered by means of weights attached to it to any moderate depth under water, it is evident that they may remain there for a considerable time, and perform any operation that could be executed on land in the same confined space. The machine, however, as thus described, is liable to two great defects, which must be obviated by other contrivances before any great advantage can be derived from it. In the first place, as the air by its compressibility allows the water to enter the lower part of the bell, the dry space is not only diminished, but the bottom on which the bell rests, and where the operations are to be carried on, is also covered with water to a proportional depth. In the second place, the air within the bell by repeated respiration soon becomes impure, and unfit to support life: so that it is necessary to elevate the apparatus after short intervals, to admit a fresh supply.

These defects were remedied by Mr. Smeaton, who contrived the plan of forcing down a continued stream of air by means of an air-pump through a flexible tube; and this plan is now always adopted. In the year 1788 Mr. Smeaton constructed a diving bell, to be used in the operations then contemplated at Ramsgate harbour, on a new and improved plan. Instead of a bell-shaped vessel sunk by weights, his apparatus consisted of a square chest of cast iron, four and a half feet long, four and a half feet high, and three feet wide, affording sufficient room for two men under it. It was cast of such a thickness that its own weight was sufficient to sink it; and its thickness was greatest near the mouth or lower part, to prevent it from being easily overset. This construction of the diving bell gave the men within it no power of raising or sinking it; but as the apparatus was made to be used at a place where the nature of the bottom was known, this disadvantage was not considered of great consequence; and, in fact, it is found by experience that it is better to leave the bell to be entirely guided from above. On account of the facility with which water conveys sound, the strokes of a hammer on the inside of the bell can be heard at a great distance; and the

sound coming through the water has a peculiar character, which cannot be mistaken. By previous arrangement, any directions can be given in this manner. For instance, one blow may denote *more air*; two, *stand fast*; three, *heave up*; four, *lower down*; and so on. With these successive improvements, the diving bell is found to be a most important machine in all great operations to be performed under water.

Divining Rod. [Rhabdomancy.]

Divisibility. The property which all bodies possess of being separable into parts. It was a question formerly much agitated among philosophers whether matter is divisible *in infinitum*; or whether a certain term does not exist beyond which the particles are reduced to simple atoms incapable of further division. The question is incapable of direct solution, and fortunately is of no importance to science; but the extent to which the actual subdivision of bodies has been carried in many cases in the arts may well be considered as prodigious. 'In the gilding of buttons, 5 grains of gold, which is applied as an amalgam with mercury, is allowed to each gross; so that the coating left must amount to the 110,000th part of an inch in thickness. If a piece of ivory or white satin be immersed in a nitro-muriate solution of gold, and then exposed to a current of hydrogen gas, it will become covered with a surface of gold hardly exceeding in thickness the ten-millionth part of an inch.'

'The solution of certain saline bodies, and of other coloured substances, exhibits a prodigious subdivision and dissemination of matter. A single grain of the sulphate of copper, or blue vitriol, will communicate an azure tint to five gallons of water. In this case the copper must be attenuated at least ten million times; yet each drop of the liquid may contain so many coloured particles, distinguishable by our unassisted vision. Odours are capable of a still wider diffusion. A single grain of musk has been known to perfume a room for the space of twenty years. Animal matter likewise exhibits in many instances a wonderful subdivision. The milt of a cod-fish when it begins to putrefy has been computed to contain a billion of perfect insects, so that thousands of these living creatures could be lifted on the point of a needle. But the infusory animalcules display in their structure and functions the most transcendent attenuation of matter. The *Vibrio undula*, found in duck weed, is computed to be ten thousand million times smaller than a hemp seed. The *Vibrio lineola* occurs in vegetable infusions, every drop containing myriads of these oblong points. The *Monas gelatinosa*, discovered in ditch water, appears in the field of a microscope a mere atom endued with life, millions of them playing like sunbeams in a single drop of liquid.' (Leslie's *Natural Philosophy*.)

Division (Lat. divisio). One of the four fundamental rules of Arithmetic, the object of which is to find how often one number is contained in another. The number to be divided is the *dividend*, the number which divides is the *divisor*, and the result of the division is the *quotient*. Division is an inverse procedure, whose effect is annulled by the *direct* operation of multiplication. Its character is *interrogative*, rather than *directive*. In order to discover the subject upon which the direct operation of multiplication will produce a given result, we must necessarily have recourse to guesses, suggested it is true by a previous knowledge of the direct operation, and test the accuracy of the procedure by multiplication. The study of the true nature of division is essential to a clear comprehension of the higher calculus of operations.

Division. In Logic, the enumeration of several things signified by a common name; thus, tree is said to be divided into oak, ash, elm, &c. A common term may be divided in several ways, according to the various points of view in which it may be regarded for the purpose of qualification. Thus a bookbinder may divide books into folios, quartos, &c.; a librarian, into theological, historical, &c.

Division. In the art Military, signifies: 1. Two or more brigades combined under a general officer [Brigade]; 2. Two guns of a battery of artillery with their personnel and equipment [Artillery]; 3. Any troops under a separate command forming part of a larger body.

Division. In Music, a dividing or separation of the interval of an octave into a number of lesser intervals.

Division. In Printing, dividing words according to custom and grammatical rule. Words of two syllables, where one of the syllables consists only of one letter, such as *brawn-y*, *cloud-y*, &c., are never divided by printers. Wide spacing in one line and close in the next is bad work; and it is therefore advisable that words should be divided in such a way as to preserve uniformity of spacing as nearly as possible.

Divorce (Lat. divortium, *a separating*). The Jewish law of divorce is founded on the directions given in Deuteronomy xxiv.; but the permission therein contained is subject to many obstacles and formalities in modern practice. In ancient Greece, the practice of divorce seems to have varied in different states; at Sparta it appears to have been unusual, in Athens great facilities were afforded by the law. In republican Rome great strictness in this branch of morals prevailed for a long period, although parties were less impeded in pursuing a divorce by the difficulties imposed by the law than by public opinion. But in the later period of the republic, and under the emperors, divorce became extremely common, and was obtained with equal ease by either sex. The answer given by our Lord to the Pharisee (St. Matt. xix.) became the foundation of the law on this subject in Christian countries, and divorces were consequently allowed in the particular case of adultery only; but after the Romish church had erected matrimony into a sacrament, they

became, as they now are in Catholic countries, wholly impossible: the only dissolution of marriage being in cases where it is void ab initio. In most Protestant countries, the facility of divorce has been so much restored in latter times as to approximate to the heathen practice. As to the English law, see MARRIAGE, LAW OF.

Do. In Music, a syllable used by the Italians instead of *ut*, being considered more musical and resonant. It corresponds to the C of the English and Germans, but is sometimes used to denote the tonic or key-note of any scale.

Dobereiner's Lamp. A small instrument for obtaining instantaneous light, in which a jet of hydrogen gas is inflamed by coming into contact with spongy platinum.

Docetæ (Gr. Δοκῆται). One of the earliest heretical sects; so called from denying the reality of our Lord's incarnation, and considering Him to have acted and suffered only in appearance. Some have conceived that the declarations of the nature of Christ in St. John's writings were directed against these opinions.

Docimasia. [DOKIMASIA.]

Docimastic Art (Gr. δοκιμάζω, *I prove*). The art of assaying minerals or ores, with the view of determining the quantity of metal which they contain.

Dock (Ger. docke). An artificial basin for the reception of ships. Docks are of several descriptions; either wet or dry, open or enclosed. The former are used for the purpose of loading or unloading a ship's cargo out of the influence of the tide, and are constructed with gates, which, when shut, keep the ship constantly afloat at low water. The second class of docks are intended for the building, repairing, and examination of ships, which are admitted into them at flood tide, and are so called because they are either left dry by the ebbing of the sea, or rendered so by the use of great flood-gates, or of pumps. The open docks are those which are, as their name implies, open to the public, such as the Liverpool and Havre docks; the enclosed ones are those where the circulation of the public is impeded by an enclosure wall, as in the London and Southampton docks, the Royal docks, &c.

Docket, Docquet or **Doggett** (Lat. documentum). In Law, an abridged entry of an instrument or proceeding on a small piece of paper or parchment. Exemplifications of decrees in chancery, fiats in bankruptcy, and other instruments, are thus *docketed* for purposes of reference.

Dockyard, Naval. A place provided with all sorts of naval stores, timber, and all the requisite machinery for shipbuilding. The principal naval dockyards for the British navy are Portsmouth, Plymouth, Chatham, Sheerness, Woolwich, Pembroke, Cork, and Malta. Each dockyard is under the control of an admiral or captain-superintendent.

Doctor (Lat. *a teacher*). This title of learned distinction was first adopted in the twelfth century. The degree of *doctorate*, succeeding and superior to that of *master* in European universities, was first conferred at Bologna; by the university of Paris, in 1145, on Peter Lombard; in England, it is supposed, in the reign of King John. Before this time, if the appellation *doctor* was used, it was only in its plain sense of *teacher*, and as synonymous with master. The degree of *doctor* is conferred, in the English universities, in each of the three faculties of divinity, law, and medicine—but not in that of arts—and in the science of music. The Continental degree of *doctor of philosophy* is unknown among us.

DOCTOR. A thin plate of steel used in scraping the colour or mordant off the copper plates employed in calico printing; the term is probably a corruption of the word *abductor*.

Doctors' Commons. The popular name for the courts and offices occupied by the body incorporated in 1768 under the title of 'The College of Doctors of Law exercent in the Ecclesiastical and Admiralty Courts.' These courts are on the southern side of St. Paul's Churchyard. The college consists of a president (the Dean of the Arches for the time being), and of those doctors of law who having regularly taken that degree in either of the universities of Oxford or Cambridge, and having been admitted advocates in pursuance of the rescript of the archbishop of Canterbury, have been elected fellows of the college in the manner prescribed by the charter. But the practical functions of this body of lawyers have been very materially diminished by the establishment of the Probate and Divorce Court, 20 & 21 Vict. c. 77. [COURTS, ECCLESIASTICAL.]

Doctrinaires (Fr.). In Politics, a cant word, originally applied in France to a section of politicians who occupied a place, in the first chambers after the restoration of 1815, between the deputies of the centre, who generally supported ministers, and the extreme left, which always opposed them. The chief men of this party were systematic writers and speakers on government, who sought to establish a frame of constitution somewhat more resembling that of England than any which has hitherto subsisted in France. The nickname given to them implied that they were considered by the public as theorists: they were, in fact, the same class which Napoleon used to term Ideologists. They supported the duc de Cazes when in office; afterwards they were generally in opposition until 1830, since which time several of their leaders have held office at different times. Royer Collard, De Broglie, the young baron de Staël, Guizot, &c., were among the chief public men commonly called Doctrinaires; but the term, like other party nicknames, has been, and is, employed in a very arbitrary manner.

Documents (Lat. documentum). In Law, written instruments adduced for the purpose of evidence. [EVIDENCE.]

Dodder (Fris. dodd, *a bunch*; Dutch. dot, *hampered thread*). A family of curious leafless parasitical plants, the slender entangled threads

like, often reddish, stems of which run over and smother the plants to which they affix themselves. The genus is called *Cuscuta*, and the more familiar species are *C. europæa*, which attacks thistles, oats, and similar herbaceous plants; *C. Epithymum*, found on heath, furze, &c.; *C. Epilinum*, which attacks flax; and *C. Trifolii*, which is sometimes a grievous pest in clover-fields. [CUSCUTACEÆ.]

Dodecadactylus (Gr. δώδεκα, *twelve*, and δάκτυλος, *a finger*). The portion of the small intestines called *duodenum*, its length being about the breadth of twelve fingers: this at least may be the case in some animals to which the dissection of the earlier anatomists, who gave this name, was limited.

Dodecagon (Gr. δώδεκα, and γωνία, *angle*). An equilateral and equiangular figure of twelve sides. Approximately, the area of a dodecagon is 11·196 times that of the square on one of its sides.

Dodecahedron (Gr. δώδεκα, and ἕδρα, *a base*). One of the five Platonic bodies or regular solids. It has twelve equal pentagonal faces, thirty equal edges, and twenty equal solid angles, each formed by the meeting of three equal plane angles. Approximately, the superficial area of a dodecahedron is 20·6457 times that of the square, and its volume 7·66312 times that of the cube on one of its sides.

Dodecandrous (Gr. δώδεκα, and ἀνήρ, *a male*). Any plant having twelve stamens.

Dodecastyle (Gr. δώδεκα, and στῦλος, *a pillar*). In Architecture, a building having twelve columns on a front, or on a flank.

Dodo. [DIDUS.]

Dodona, Oracle of. A celebrated oracle in Epeirus, sacred to Jupiter. In some legends its origin is attributed to Deucalion; according to the traditions of the priestesses of the temple, it was founded by a dove, which, perching on the branch of an oak, recommended in a human voice that a temple should be erected to Jupiter in that place. In the Homeric age this oracle was in Thessaly. (Homer, *Iliad* 16, 233; Gladstone's *Homer and the Homeric Age*, i. 106.) The legends of the foundation of the oracle are related by Herodotus, ii. 55, &c. [ORACLE.]

Dodrans (Lat.). A measure equal to about nine inches, being the space between the end of the thumb and of the little finger when both are fully extended. It is about equal to the *palm*.

Doeglic Acid. An oily acid contained in some kinds of sperm oil.

Dog. [CANIS.]

Dog Belts. A term used in some coal mines for a strong broad piece of leather round the waist, to which a chain is attached, passing between the legs of the men drawing the dans in the low works.

Dog Days. [CANICULAR DAYS.]

Dog Rose. *Rosa canina*. Wild Brier. The fruit of this tree, called *hips*, is the source of a conserve, used in Pharmacy.

Dog Star. A name popularly given to *Sirius*, a star of the first magnitude, in the constellation *Canis major* (the Greater Dog), and the brightest fixed star in the firmament.

Dog's-leg Staircase. A staircase of wood in which there is no well hole, and in which the side strings of the half flight finish in the newel at the landings, or at the turn of the stairs.

Dog's-tooth Spar. A name given to certain pointed crystals of Calcspar, from their fancied resemblance to the tooth of a dog. They are principally found in Derbyshire, and at Ecton in Staffordshire.

Doge (from Lat. dux, ducis, *a leader*). The title of the supreme executive magistrate in the republic of Venice. The origin of this office dates as far back as 697; when, owing partly to the dissensions and intrigues that resulted from the annual election of the seven tribunes by whom the affairs of Venice had been previously administered, and partly to so divided an authority being found inadequate to the conduct of the rapidly increasing powers of the state, the Venetians resolved to replace the tribunes by a single chief magistrate, who should hold office for life. This magistrate, whom they called *the Doge*, was clothed with almost regal authority. In him was vested the power of convoking assemblies, of declaring war or concluding treaties; of commanding the armies of the state; of appointing the military tribunes and the judges; of hearing appeals and deciding definitively on all matters at issue; of collecting the citizens in the different quarters or districts of Venice, for the purpose of choosing their parish priests or bishops; of judging all matters concerning the clergy in all causes, both civil and criminal; and of awarding ecclesiastical punishments, investing the bishops, and installing them in their churches. (*And. Dandolo apud Gallicioli. Chron.* i.) But notwithstanding these apparently vast powers which were vested in the doge at the first institution of the office, the slightest glance at the history of Venice, which for more than eleven centuries, with a few interruptions, continued to be governed by doges, will abundantly prove that though the Venetians allowed four centuries to elapse before they attempted to fix the bounds or control the exercise of the sovereign authority by any legal enactments, they never ceased to regard with jealousy the chief magistrate of their own appointment and approval, and at last succeeded in limiting and restricting his power, so as to render him a mere state pageant of the *grand* council, in which resided the supreme executive authority. (Daru's *Histoire de la République de Venise*, 8 vols. 8vo. Paris; *Quarterly Review*, vol. xxxi.; *Edinburgh Review*, vol. xlvi.) [BUCENTAUR.] *Doge* was also the title given to the chief magistrates of Genoa, who were elected from the senatorial body. The doges of Genoa held office originally for life, as at Venice; but from 1528 down to 1797, when that form of government was abolished by the French, they remained in office only two years, and their authority was exceedingly circumscribed.

Dogger (Fr. dogre). A two-masted fishing boat, of the ketch build, with bluff bows. It is used principally by the Dutch for the Dogger-bank fishery. In the Dutch and Scandinavian languages the dogger is known as a *pink*.

Dogma (Gr. *a decree*). In Theology, *dogma* has been defined to be a fundamental article of belief derived from acknowledged authority, and is usually applied to what are considered the essential doctrines of Christianity, deduced either from the Scriptures or from the fathers of the church. [THEOLOGY.] There are, however, many other *dogmas* peculiar to the different sects into which Christianity is divided. *Dogmatic theology*, as this branch of divinity is called, in contradistinction to moral and scholastic theology, forms an important object of study in many of the Continental universities. In the Protestant universities of Germany, there are chairs set apart for the history of *dogmas*, or, as it is termed, *Dogmatik*; in which the origin and nature of the dogmas of the various Christian sects are examined, and the merit of the arguments by which they are supported respectively canvassed. Among the ancient physicians, the *dogmatists* founded their practice upon conclusions or opinions drawn from certain theoretical inferences, which they conceived might be logically defended or proved.

Dogwood. A name applied to various plants: in England and North America to the shrubby species of *Cornus*; in the West Indies to *Piscidia erythrina*; and in Tasmania, to *Bedfordia salicina*. Some of the North American species of Cornus, especially *C. florida*, are valuable trees. The *Piscidia* is a powerful narcotic, and is used as a fish-poison in Jamaica.

Dokimasia (Gr. from δοκιμάζω, *I prove*). In Greek Antiquities, the examination passed by Athenian magistrates before entering on their office. It embraced their past life generally, and their special fitness for the post for which they had been chosen; and any citizen might then object to the appointment. At the end of their term of office, they had to pass a second examination termed Euthyne (from Gr. εὐθύνω, *I set straight*). Except in offices involving the administration of public moneys, it was simply an appearance before the magistrates, when, if no charge was preferred against them, they were dismissed free of further obligation.

Dolabriform (Lat. dolabra, *an axe*, and forma, *form*). In Botany, applied to those bodies, principally leaves, which are fleshy, compressed towards the upper end, with one border thick and straight, the other thin and convex.

DOLABRIFORM. In Zoology, when a whole or part is shaped like a hatchet, as the foot of certain Bivalves.

Dolce (Ital.). In Music, an instruction to the performer that the music is to be executed softly and sweetly.

Dolerite. A trap-rock composed of augite and felspar.

Dolichokephalic (Gr. δολιχός, *long*, and κεφαλή, *head*). Professor Retzius used this word to denote those skulls in which the proportion of the transverse to the longitudinal diameter is less than $\frac{8}{10}$. The West African negro is an example of the dolichokephalic type of skulls, to which the majority of the African races belong. No exact classification, however, can be formed upon the mere length and breadth of the skull, a character variable in nearly allied races.

Dolichos (Gr. *long*). A genus of *Leguminosae* consisting of herbaceous or shrubby twiners with trifoliolate leaves, the flowers succeeded by pods, which are sometimes esculent. *D. sesquipedalis*, a native of South America, and cultivated in the warmer parts of Europe, has cylindrical pods a foot and a half long, which form an excellent dish when cooked young. The *D. tuberosus* of Martinique yields a fleshy tuber, as well as pulse, both of them edible; and *D. uniflorus* is grown for food in India under the name of Horse Grain. The *Dolichos pruriens* of Linnæus is the *Mucuna pruriens* of De Candolle; it furnishes the article of the materia medica known as Cowitch. [COWHAGE.]

Dolichotis (Gr. δολιχός, *long*, and οὖς, *an ear*). The name applied by F. Cuvier to the subgenus of Cavies, to which the Patagonian hare (*Cavia Patachonica*) belongs.

Dollar. [MONEY.]

Dolmen. Celtic monuments, consisting of two vertical stones and a horizontal one; they are usually erected in isolated positions, and are supposed to have served as altars.

Dolomite (after Dolomieu). In Geology. [PERMIAN AND MAGNESIAN LIMESTONE.]

DOLOMITE. In Mineralogy, a specific name for the rhombohedral compounds of carbonate of lime and magnesia. It includes the varieties Pearl Spar, Bitter Spar, Mesitine Spar, and Breunnerite.

As a rock, the name is given to limestones containing carbonate of magnesia, those varieties that approach nearest in composition to equivalent combinations of the two carbonates yielding the most durable building-stones. In England, fossiliferous dolomites form the most part of the Permian Limestones from Durham to Nottinghamshire; and certain beds of the Carboniferous Limestone are, also, dolomitic. In the Tyrol, Canada, and other mountain districts, local masses of limestone are found to be changed into crystalline dolomites over extensive areas.

Dolomitic Conglomerate. Near Bristol and elsewhere, the unconformable beds of the lower new red sandstone, resting immediately on the coal, consist of a deposit known under this name. It is a breccia of fragments, often angular, composed of old rocks, chiefly carboniferous, cemented by a red or yellow paste of dolomite or magnesian limestone. This deposit contains fossil remains of some remarkable species of reptiles, for a long time regarded as the most ancient forms of reptilian life. Other

reptilian bones have since been found in the coal measures.

Dolphin (Gr. δελφίς). This term is applied, in common language, to two inhabitants of the ocean of widely different habits and organisation: by naturalists it is generally used to signify the dolphin of the ancients, which is a cetaceous mammal of the genus *Delphis* of Linnæus; by poets it is applied to the coryphene (*Coryphæna Hippurus*, Linn.), a fish long celebrated for the swiftness of its swimming. and the brilliant and beautiful colours which it successively assumes in the act of death.

Dom (Lat. dominus, *a lord*). In the middle ages, a title originally possessed by the pope, and at a somewhat later period by the dignitaries of the Roman Catholic church. In more recent times, it formed a distinguishing title of certain monastic orders, such as the Benedictines, &c.; and it appears to have been equivalent to the *don* of the Spaniards, the *von* of the Germans, and the *de* of the French. Mabillon and Calmet are always spoken of as Dom Mabillon and Dom Calmet.

Domain (Lat. dominicum, from dominus, *lord*; in legal language, *demesne*). Signifies properly that portion of the territorial possessions of a lord which he retains in his own occupation. Thus, the lands retained in possession of the crown, and not granted out to the great feudal lords, were styled *domaines* in France. *Ancient demesne*, in English law, is a peculiar tenure by which certain lands are held of the crown, being such as are evidenced by Domesday Book to have been in the possession of King Edward the Confessor.

Dome. In Architecture, the spherical, or other figured, concave ceiling, over a circular, or a polygonal, building; in the latter case, when the spherical shape is given, the dome is said to spring from pendentives, or the means of overcoming the difference of plan. A *surbased* or *diminished dome* is one that is segmental in its section; a *surmounted dome* is one that is higher than the radius of its base. The forms of domes are various both in plan and in section. In the former, they are circular or polygonal; in the latter we find them semicircular, semi-elliptical, segmental, pointed sometimes in curves of contrary flexure, sometimes bell, &c. The oldest dome on record is supposed to be that of the Pantheon of Rome, which was erected under Augustus, and is still perfect. A list of the domes whose dimensions entitle them to notice is here subjoined:—

Domes	Internal Diameter	Internal Height
	ft.	ft.
Pantheon at Rome . .	142·6	143
Baths of Caracalla . .	112	116
Duomo of Florence, Sta. Maria del Fiore	139	310
St. Peter's at Rome . .	139	330
Sta. Sophia, Constantinople .	104	201
St. Paul's, London . .	112	215
Dome of the Mosque of Achmet	92	120
Chapel of the Medici . .	91	199
Baptistery of Florence . .	86	110
Church of the Invalides, Paris	80	173
Minerva Medica at Rome .	78	97
Madonna delle Salute, Venice	70	133
St. Geneviève, Paris . .	67	190
Duomo at Sienna. . .	57	148
Duomo at Milan . . .	57	254
St. Vitale at Ravenna . .	55	91
Val de Grace at Paris . .	55	133
St. Mark's, Venice . .	44	150
Halle aux Blés, Paris . .	131	150
St. Isaac, Petersburg . .	96	150

Domesday Book (*Liber Judiciarius*, or *Censualis Angliæ*). Was framed by order of William the Conqueror, and contains a general survey of most of the lands in England, their extent in each district, their proprietors, tenures, value; the quantity of meadow, pasture, wood, and arable land which they contained; and, in some counties, the number of tenants, cottagers, and slaves of all denominations who lived upon them. The meaning of the term *domesday* is still disputed. (Hallam, *Middle Ages*, ch. ix. part ii.)

Domesday Book consists of two volumes; one in fol., the other in 4to.: the former comprehending thirty-one counties, the latter those only of Essex, Norfolk, and Suffolk. The counties of Northumberland, Cumberland, Westmoreland, and Durham were not comprehended in this survey, probably on account of their then wild uncultivated state. Nor does Lancashire appear under its proper name; but Furness and the northern part of that county, as well as the south of Westmoreland and part of Cumberland, are included within the West Riding of Yorkshire. Though in several respects the information contained in Domesday Book is inaccurate and defective, still it serves admirably to illustrate the ancient state of England. The publication of Domesday Book was undertaken by order of George III. in 1767, and was completed, under the superintendence of Mr. Abraham Farley, in 1783. The original is deposited in the Record Office. Sir H. Ellis has published a useful introduction and index to it. Two volumes of Records supplementary to Domesday Book, framed for a similar purpose, and of a nearly contemporary date, were published in 1816 by the Commissioners upon the Public Records. The printing of these works was in facsimile, as far as Roman types, assisted by the representation of the mediæval contractions, could be made to imitate the original. But those lately produced in photozincography, by Sir Henry James, of the Ordnance Survey Office, Southampton, completed at the end of 1863, of course are perfect facsimiles. The following are the abbreviations used in Hutchin's *Domesday Book* for the county of Dorset:—

āc, *acræ.*
æccl̄a, *æcclesia.*
arch̄, *archiepiscopus.*
car⁴, *caruca, carucata.*
dim⁴, *dimidium.*
dn̄io, *dominio.*
ead̄, *eadem.*
7, *et.*
ē, *est.*
eccl̄am, *ecclesiam.*
ep̄us, *episcopus.*
fr̄s, *fratres.*
geldb̄, *geldabat.*
h̄, *hoc* or *hæ.*
leu⁴, *leuca.*
lib̄, *libræ.*
lḡ, *longa*, longitudinem.
lat⁴, *lata*, latitudinem.
ꝟ, *manerium* or *manerio.*
molin̄, *molini.*
m̄, *modo.*
nūq, *nunquam.*
in paraḡ, *in paragio.*
pˊposit⁹, *prepositus.*
pb̄r, *presbyter.*
p"ti, *prati.*
ꝑtin⁴, *pertinet.*
ꝓ, *pro.*
h̄t, *habet.*
ꝓpt', *propter.*
ꝗt xx^ti 7 ix, 89.
q̊, *quæ.*
q̇, *qui.*
q̇, *quo.*
q̈z, quarent⁴, q̄rent, *quarentenæ.*
q̄dā, *quædam.*
redd̄, *reddunt, reddit.*
solid̄, *solidi.*
s̄t, *sunt.*
tam̄, *tamen.*
tant⁴, *tantum.*
t⁴nt⁴d', *tantundem.*
t⁴ciā, *terciam.*
T. R E. *tempore regis Edwardi.*
T. R. W. *tempore regis Willelmi.*
ten⁴, *tenet.*
Tr⁴a, *terra.*
voleb̄, *volebat* or *volebant.*
vill̄i, *villani.*
v⁴, *virgata.*
un⁹, *unus.*
ū, *vero.*

Domicile. In Law, the place where a person has his home. Personal property, on the decease of the owner, is distributable according to the law of the country in which he was domiciled at the time of his death; not according to the law of the country in which the property is situate. Residence for forty days constitutes a domicile as to jurisdiction in Scotland.

Dominical Letter. For the purpose of exhibiting the day of the week corresponding to any given day of the year, the framers of the ecclesiastical calendar denoted the seven days of the week by the first seven letters of the alphabet, A, B, C, D, E, F, and G; and placed these letters in a column opposite to the days of the year, in such a manner that A stood opposite the 1st of January or first day of the year, B opposite the 2nd, and so on to G, which stood opposite the 7th; after which A returns to the 8th, and so on through the 365 days of the year. Now if one of the days of the week, Sunday for example, falls opposite to E, Monday will be opposite to F, Tuesday G, Wednesday A, and so on; and every Sunday through the year will be represented by the same letter E, every Monday by F, and so on. The letter which represents Sunday is called the *Dominical Letter*, or *Sunday Letter*. As the number of days in the week and the number in the year are prime to each other, two successive years cannot begin with the same day; hence the Dominical Letter changes every year. This mode of representing the days of the week has now fallen nearly into desuetude, and the initial letter of the name of the day is placed in our almanacks opposite the day of the month.

Dominicans. Friars of the order of St. Dominic, instituted at the beginning of the thirteenth century. [ORDERS, MENDICANT.]

Domino (Ital.). A long loose cloak of black silk, furnished with a hood removable at pleasure, and worn chiefly at masquerades by persons of both sexes by way of general disguise. [MASQUERADE.]

Domite. A volcanic rock (porphyritic trachyte) forming the Puy de Dôme, in Auvergne.

Don (Lat. dominus). A Spanish title, which the king, the princes of the blood, and the highest class of the nobility prefix to their names. The title *donna* given to ladies represents the Latin *domina.*

Donatists. A religious faction, which arose in Africa in the beginning of the fourth century in opposition to Cæcilianus, bishop of Carthage. The Numidian bishops were indignant at a slight received from him at the time of his consecration, and declared him informally appointed, on account of their absence from the ceremony. They also accused him of unworthy conduct during the Diocletian persecution. There are two persons of the name of Donatus celebrated as leaders of this party. Their cause was heard before several councils (those of Arles, Milan, and Carthage), in all of which they were pronounced schismatics. The Donatists, however, continued to be a powerful faction for more than one hundred years, and raised at various times great wars and commotions. The name CIRCUMCELLIONES [which see] was given to the numerous bands of country people of the lowest ranks who took up arms in their cause. St. Augustine was most successful in bringing public opinion to bear against the Donatists.

Donative (Lat. donativum). In Law, a benefice merely given and collated by the patron, without presentation, institution or induction. This, it is said, was the original way of conferring benefices in England, the interference of the bishop being a later encroachment, ascribed by some to Becket.

Donjon or **Dungeon.** Originally a fortress on a hill: from the Celtic dun, *height*. The central building or keep of an ancient castle; frequently raised on an artificial elevation.

Donkey Engine. A small engine used to supply water to the boilers of large engines, or to perform some minor works, when the large engine is not in full operation.

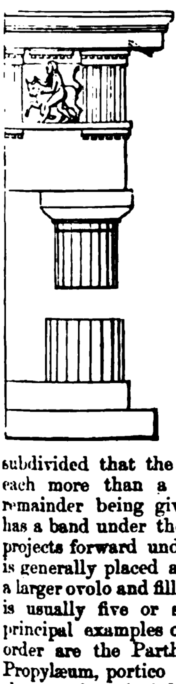
Door (Gr. θύρα, Ger. thor, Sansc. dvâr). In Architecture, this word is applied to the gate or the entrance to a house, or to the means by which access is obtained to the inner apartments on the same floor as the bottom of the door. The door frame is the surrounding case into and out of which the door shuts and opens. It consists of two upright side pieces,

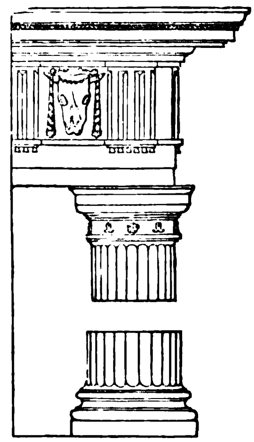
or posts, and a head, generally fixed together by mortices and tenons, and wrought, rebated, and beaded. The door itself is either panelled on both sides, with mouldings in the panels, or it may be finished square, bead flush, bead butt: it may be either a ledged door, a clamped door, or a framed door.

Dorado (Span. *gilt*). A southern constellation, formed by Bayer; called also sometimes the *Sword-fish*.

Dorema (Gr. *a gift*). The name of certain umbelliferous plants from Persia, one of which, *D. ammoniacum*, furnishes the drug *Ammoniacum*. The plant abounds in a milky juice, which exudes on the slightest puncture, and dries in the form of little rounded lumps or tears. The ammoniacum of the ancients has, however, been ascribed to *Ferula tingitana*.

Doric Order. In Architecture, one of the five orders. The true origin and birthplace of this order are not known. The example here given is from the temple of Theseus at Athens, which is considered one of the best examples of Grecian Doric. The principal points in which the Grecian differs from the Roman Doric are, that the former stands at once on the pavement of the building, without socle, tori, or fillets; and that it presents a more pyramidal section than the latter, from the great diminution given to it. Its flutes, too, are never deeply sunk; the capital has no astragal, but only some annulets to separate it from the shaft. The entablature is so subdivided that the architrave and frieze are each more than a third of its height, the remainder being given to the cornice, which has a band under the mutulus. The mutulus projects forward under the corona, over which is generally placed an ovolo and a fillet, with a larger ovolo and fillet above them; the column is usually five or six diameters high. The principal examples of this modification of the order are the Parthenon, temple of Theseus, Propylæum, portico of the Agora at Athens, the temple of Athena at Sunium, one at Corinth, temple of Apollo and portico of Philip in the island of Delos, &c. The Roman Doric differs considerably from that above described, as will be seen by comparing the drawings of the two. From the diagram of the Roman modification of the order, it will be seen that the triglyphs are always placed over the centre of the columns, and the metopes should form an exact square. It follows, then, that the intercolumniations are always regulated by the triglyphs. Sometimes the column is placed on a plinth, at other times on a pedestal sparingly decorated with mouldings. Though it occasionally, as in this example, has an Attic base, it is more commonly used with only a torus and an astragal. The capital is formed with a neck and astragal under the ovolo, and a cyma reversa and fillet on the abacus. The only pure ancient example of this order is that of the theatre of Marcellus at Rome; the flutes are without fillets between them, as in the Grecian Doric, and are twenty in number. Of the modern architects, by far the most successful in his profile of the order, which has been converted into what may be called the Italian Doric, is Palladio, from whose works the example given above is extracted.





Doripps. A genus of the short-tailed Decapod Crustaceans, belonging to the tribe *Notopoda*. The species of this genus exist at great depths in the sea, and it is probable that they use the small feet, which are directed towards the back, to cover themselves with foreign bodies for concealment: they have been found in the Mediterranean, Adriatic, and Indian seas.

Dormer (Fr. dormir, *to sleep*). In Architecture, a window inserted on the inclined plane of the roof of a house, the frame being placed nearly vertically with the line of the rafters. The Gothic architects frequently made their dormer windows an important detail in their compositions. The word originally signified a *sleeping apartment*.

Dormitory (Lat. dormitorium, from dormio, *I sleep*). In Architecture, a large sleeping apartment capable of containing many beds.

Dormouse (Lat. dormio, *I sleep*). A genus of Rodent Mammalia, in which the hibernating faculty is exceedingly developed. Three species are known in Europe, the Loir (*Myoxus Glis*), the Lerot (*Myoxus Nitela*), and the Muscardin (*Myoxus avellanarius*). The last and smallest species is the one which is most common in England.

The last syllable of the word *dormouse* is probably nothing more than false etymology. In Suffolk this animal is called a *sleeper*. [Glis and Myoxus.]

Dornock. A stout figured linen, named after the town in Scotland where it was originally manufactured.

Dorsibranchiates, Dorsibranchiata (Lat. dorsum, *back*; branchiæ, *gills*). A name given by Cuvier to an order of Anellidans, or

red-blooded worms, comprehending those which have the gills projecting from the middle part of the back or sides of the body. The Nereis, or sea-centipede, is an example of this order.

Dort, Synod of. An assembly of Protestant divines convoked at Dort in 1618–19, by the States-General, under Maurice, prince of Nassau, in which the tenets of the Arminians on the five points relating to election, redemption, original sin, effectual grace, and perseverance, were condemned by the adherents of Calvinism. This national synod consisted of thirty-eight Dutch and Walloon divines, five professors from different universities, and twenty-one lay elders; but besides these there were ecclesiastical deputies present from most of the states of the United Provinces, and from the churches of the Palatinate, Hesse, Switzerland, Bremen, England, and Scotland. This synod was opened on November 13, 1618, and continued till May 29 in the following year, during which period it held 180 sessions; but long before these sessions had come to a close, the Arminians were condemned as corruptors of the true religion. It was at this synod that the project of obtaining a translation of the Bible into Dutch was first started. The execution of this task was intrusted to some of the most learned men of the time; and after the lapse of nineteen years their labours were given to the world in what has been since known as the *Dort Bible*. [ARMINIANS.]

Dositheans. The name of a religious sect which sprang up in the first century of the Christian era. Their principal tenets consisted in believing in the divine mission of their leader, Dositheus, from whom they derived their name, and in rejecting the authority and inspiration of the prophets.

Double Bass. [CONTRABASSO.]

Double Dagger. In Printing, a character marked thus ‡, used as a reference to notes in the margin of the page.

Double Letters. In Printing, those types, such as the f, i, and l, which, when used in combination, are apt to be broken in locking up the form of types. They are therefore cast in one piece, or logotype, as ff, fi, fl, &c. The diphthongs æ and œ are also cast as double letters.

Double Pica. [PICA.]

Double Point. In the theory of *curves*, a point through which the curve passes twice. [NODE.] Of the infinite number of lines through a double point, all of which meet the curve in two coincident points, there are two, and only two, which meet the curve in three coincident points; these are the *tangents at the double point*. When these tangents are real and distinct, the point is frequently called a *node*; when real and coincident, a *cusp*; and when imaginary, a *conjugate* or *isolated point*. A plane curve of the n^{th} order will not have double points unless the discriminant of its equation vanish, and a *proper* curve of this order cannot have more than $\frac{(n-1)(n-2)}{2}$ double points. Every double point of a curve is also a double point on its Hessian, and both these curves have the same tangents at each such point.

In the theory of *surfaces*, a point is said to be a double one when the surface is there cut by any right line whatever in two coincident points. Through such a double point an infinite number of lines can be drawn, each of which will meet the surface in *three* coincident points; and as all such lines lie on a tangent cone, a double point is sometimes called a *conical point*, and sometimes also a *node*. The terms *biplanar node* and *uniplanar node* are used to distinguish the cases where the cone in question breaks up into two distinct, and into two coincident planes. [NODE.] A curve every point of which is a double point on the surface is called a *double or nodal line* or *curve*. The condition that a surface should possess double points is found by equating to zero the discriminant of its equation.

Double Points of an Involution. [INVOLUTION.]

Double Stars. [STARS, DOUBLE.]

Double Tangent Line of a Surface. A line which touches the surface twice or in two pairs of coincident points. To possess double tangent lines, it is clear that the order of the surface must exceed the third; when this condition is fulfilled, however, it will be possible to draw innumerable such lines: in fact, $\frac{1}{2}n(n-1)(n-2)(n-3)$ double tangent lines of a surface of the n^{th} order will, in general, pass through any point in space, and there are $(n+2)(n-3)$ such lines which have one of their points of contact coincident with a given point, and which, consequently, lie in the tangent plane at that point.

Double Tangent Plane. A plane which touches a surface, or a non-plane curve, twice. A surface of sufficiently high order, say n, has an infinite number of double tangent planes, since a plane requires but three conditions for its complete determination, and their points of contact lie on a curve of the order $n(n-2)(n^3-n^2+n-12)$. The number of double tangent planes which pass through any point in space is

$$\tfrac{1}{2}n(n-1)(n-2)(n^3-n^2+n-12).$$

(Salmon's *Analytical Geometry of Three Dimensions*.)

Double Tangent of a Plane Curve. A line which touches the curve twice, that is to say, a line which meets the curve in two pairs of coincident points. It is obvious that only curves of the fourth or of higher order can possess double tangents. The latter, however, will, in general, possess them, since a right line can be made to satisfy two conditions. The points of contact of a double tangent may be imaginary, real and distinct, or real and coincident. We may conceive the last case to arise when of the *tangentials*, or points in which a simple tangent cuts the curve again, one coincides with the point of contact; so that a double tangent with coincident points of contact must be regarded as a *stationary tangent*, and its point of contact a *point of inflexion*. The

subject of double tangents has been treated by Plücker (*Theorie der Alg. Curven*, 1839), who first showed that a curve of the n^{th} order has in general $\frac{1}{2}n(n-2)(n^2-9)$ such tangents; by Jacobi, Hesse, Steiner, and others (Crelle's *Journal*); and finally, by Salmon and Cayley (*Phil. Mag.* 1858, and *Phil. Trans.* 1859), who gave the complete solution of the problem which requires their determination.

Double-acting Pump. A pump that lifts and forces water alternately on each side of the course, by means of a solid piston or plunger, and an entrance and exit valve, communicating with each side.

Double-banked. In speaking of rowing, signifies that the rowers sit side by side in twos, a pair of oars being worked from each thwart. This can only be practised in wide boats.

Doubloon. [MONEY.]

Douche (Fr.). A jet or current of water directed upon some part of the body. An apparatus for this purpose is to be found in most bathing establishments. Steam or vapour is also sometimes applied in the form of douche.

Dovecot. A structure for keeping tame pigeons; the only essential difference between which and a common poultry-house is, that the entrance for the birds must be raised to a considerable height from the ground, because pigeons fly higher in the atmosphere than most other birds.

Dover's Powder. A compound of ipecacuanha, opium, and sulphate of potash. It is the *pulvis ipecacuanhæ compositus*, or compound powder of ipecacuanha, of the Pharmacopœia. Ten grains, which is the average dose, contain one grain of opium and one of ipecacuanha. It is an excellent sedative and sudorific.

Dovetail. In Architecture, a joint used by carpenters in connecting two pieces of wood, by letting one piece into the other in the form of the expanded tail of a dove. It is the strongest way of joining masses, because the tenon or piece of wood widens as it extends, so that it cannot be drawn out, because the tongue is larger than the cavity through which it would have to be drawn. The French call this joint a *queue d'hironde*, or swallow's tail.

Dowager (Fr. douairière). A widow endowed: that is, who either enjoys a dower from her deceased husband, or has property of her own brought by her to her husband on marriage (dowry), and settled on herself after his decease. In the language of etiquette the term is applied to a widow lady, to distinguish her from the wife of her husband's heir having the same title.

Dowel. The name given originally to a pin used horizontally for joining two pieces of material, the dowel being inserted in its socket on the one piece before the other substance with the socket is forced into its place. When used in stone-work, the dowels are subsequently run with cement, or lead, and occasionally with sulphur.

Dower (Low Lat. dotarium, from dos). In Law, is defined to be the estate for life which a widow acquires in a certain portion of her husband's real property after his death. Dower by the common law entitles her to a third part of all the ands and tenements of which the husband was seised in fee simple or fee tail at any time during the coverture. Hence this species of dower could not be affected by the husband's conveyance of the lands, unless by fine or recovery in which the wife joined, or by his devise. But the law in this respect has undergone material alteration by the provisions of the 3 & 4 Wm. IV. c. 105. Dower by custom varies in different districts. There were other obsolete species of dower, now abolished by the statute already mentioned. A married woman may be deprived of her right to dower by attainder of her husband for treason, or herself for treason and felony; by divorce à vinculo matrimonii; by elopement from the husband and living with an adulterer, which incapacity may be removed by the reconciliation with the husband. In order to prevent the inconveniences occasioned by this right, which materially impeded the conveyance of property, various modes of *barring*, i.e. defeating, the right to dower were invented by legal ingenuity. Of these the most usual in practice was and still is the limitation of a separate estate (commonly, although incorrectly, called a *jointure*) to the wife on marriage. This estate must be 'a competent livelihood of freehold for the wife, of lands.'

Dowlas. A coarse kind of linen.

Downs. Have been defined to be banks or elevations of sand which the sea gathers and forms along its shores, and which serve it as a barrier. The word is derived from the Celtic DUNES [which see]. The term is also applied to large tracts of poor naked hilly land which serve chiefly for the grazing of sheep, thence called *down sheep.*

DOWNS is also the name given to the well-known road for shipping in the English Channel, which possesses excellent anchorage, and in time of war forms the place of rendezvous for the English navy.

Dowry. Although often confounded with *dower*, has a different meaning; namely, the *dos mulieris* or marriage portion brought by the wife to her husband. The word, however, has no legal signification.

Doxology (Gr. δοξολογία). A form of praise or glorification. The greater and lesser Doxologies, as they are distinguished by the liturgical writers, are the angelic hymn, 'Glory be to God on high,' &c.; and the shorter form, 'Glory be to the Father,' &c. The last clause in the Lord's Prayer, as given by St. Matthew, the genuineness of which has been sometimes questioned, is also frequently called the Doxology.

Drachm (Gr. δραχμή). There are two drachms in our system of weights; namely, the avoirdupois drachm, which is the sixteenth part of the avoirdupois ounce; and the apothecaries' drachm, which is the eighth part of the troy ounce, and equivalent to sixty troy grains: the

latter drachm is the only one which is retained in common use.

Drachma (Gr. δραχμή). An Athenian silver coin of the value of six oboli, or about $7\frac{3}{4}d.$ of our money. Other Greek states had *drachmæ* of different values, but the above is that generally referred to. There was also a weight of this name nearly equivalent to 2 dwt. 7 gr. troy weight.

Draco (Lat. *the Dragon*). One of the ancient constellations in the northern hemisphere.

Draco Mitigatus (Lat.). An alchemical name of *calomel*: corrosive sublimate was probably called *draco* or the dragon.

Draconin or **Dracina.** The colouring matter of the resin called *dragon's blood.*

Draconyl. A hydrocarbon obtained from dragon's blood resin.

Dragomans. The interpreters attached to European embassies or consulates in the Levant. The dragoman of the Sublime Porte is an important Turkish officer, who forms the medium of communication between his own government and the embassies of foreign countries.

Dragon (Gr. δράκων). One of the most famous mythological creations of antiquity and the middle ages. It occurs in the sacred allegories of the Jews, and in the legends of the Chinese and Japanese; and the pages of the poets of Greece and Rome teem with representations of the dragon. Thus the dark retreats of their gods and their sacred groves were defended by dragons. In the Vedic mythology, the dragon Vritra is the antagonist of Indra; and in the Greek myths, a dragon kept the garden of the Hesperides, &c. In the Scandinavian mysteries, the dragon was the minister of vengeance under their vindictive gods. (Grimm's *Deutsche Mythologie.*) The allegory of the Dragon has also found a place among many nations who have embraced Christianity. In the Book of Revelations, the angel is represented as laying 'hold on the dragon, that old serpent, which is the devil;' and hence in painting and statuary the triumph of Christianity over infidelity and heathenism is sometimes represented by a dragon pierced or trampled under foot. This representation forms also the attribute of different saints, in the legends of Christianity, more especially of St. Michael and St. George. On the origin of the Dragon in mythology, see Max Müller's 'Comparative Mythology' in *Oxford Essays* for 1856, p. 66 &c.; Bréal, *Hercule et Cacus.*

Dragon. In Zoology, this term is applied to a genus of small Saurian reptiles, characterised by two lateral aliform productions of the skin supported upon the first six pairs of ribs; which, instead of bending round the thorax, are elongated and directed outwards for that purpose.

Dragon Beam. In Architecture, a horizontal piece of timber upon which the hip, or angle rafters of a roof, pitch. It is framed into a short diagonal piece which ties the plates at the internal angles of a roof. Properly speaking, this should be written *dragging piece.*

Dragon Fly. A common name for the Neuropterous insects belonging to the genus *Agrion* or *Libellula.*

Dragon's Blood. A deep red resin used in colouring varnishes; it is the produce of the *Pterocarpus draco*, and is imported from India.

Dragon's Head. In Heraldry, part of the celestial constellation Draco, used in ancient English emblazonments to denote tenne, or orange-colour, in the arms of sovereigns. The *Dragon's tail* was also used to denote sanguine.

Dragonnades (Fr.). The name given to the persecutions instituted by Louis XIV. and his successor against the French Protestants, from the coercive measures (parcequ'on y employait les *dragons*) which were put in force to effect their conversion.

Dragonnée (Fr.). In Heraldry, a lion or other beast whose upper half resembles a lion, &c., but the lower half that of a dragon.

Dragoons (Fr. dragon; probably so called from the musket, Dragon—in English, *Drake*—which they carried: Markham's *Souldier's Accidence*, 1645). The name given to a species of cavalry originally trained and armed to act either on foot or on horseback, as emergencies might require. The origin of this species of troops has been ascribed by Père Daniel to the maréchal de Brissac. They were at first armed with pikes and muskets. In 1682 we find the pike gone, and a sword substituted; gradually they ceased to act as infantry, and became armed as now with carbine and pistols, and the sword for their chief weapon. At present dragoons form part of the military force of all the powers of Europe. The first regiment of dragoons in this country was raised in 1681, and called the Royal Regiment of Dragoons of North Britain, now the *Scots Greys.* In England, there are *dragoons* and *dragoon guards*; the difference between them consisting in this, that the accoutrements and horses of the latter are somewhat heavier than those of the former. [Cavalry.]

Drain. A channel on or below the level of the ground by means of which water is conveyed to the principal discharging course of the district. According to the nature of the water so to be removed, a drain may be open or covered, permeable or impermeable; and according to the importance which the parts of a system of drainage bear to the whole, they are called *main or arterial drains*, and *subsidiary drains.* When used for removal of the waste waters of towns, main drains have latterly been very incorrectly named *sewers*, whether they be open or closed; the conduits for the relief of separate premises being specifically known as *drains.* For agricultural drainage, pipes made of clay of from one inch to six inches diameter are used; for house drainage the pipes are made from six inches to twelve inches in diameter: the inclination to be given to a six-inch house drain should

be at least one in eighty, in order to keep it clear.

Draining. In Economic Geology. So far as it depends on geological structure, draining is one of the departments of practical or economic geology. Surfaces are naturally drained by rills and streams worn on the surface by running water; but it is evident that this can only be the case when there is a slope. When also the natural slope is interfered with by barriers of rock, or by accidental obstructions, water will accumulate and require to be got rid of. Such drainage sometimes takes place by natural fissures. If this is not the case, various contrivances are necessary, depending greatly on geological conditions. On a large scale these operations require engineering operations.

Drainage of soils may sometimes be effected by opening a communication with some permeable rock below. More frequently advantage must be taken of the form of the surface to carry the water from a higher to a lower level, whence there is a natural outfall to the sea. When water meanders through a clayey district, or one of which the surface is soft, there is a tendency to increase the windings. This can, however, be counteracted by artificial cuts. The water naturally takes the shortest way, its current is increased in the short cut, and, part of the sluggish water still slowly permeating, the curve tends to silt up the old channels. Thus a systematic drainage will help itself, and recover a former good channel closed by interruptions.

Drainage not only carries away superfluous water, but actually deepens and improves a soil, besides being an important preparation for engineering and architectural works. No foundation can be stable, and no building free from the chance of dry rot, if attention is not paid to the drainage and the geological circumstances of the site.

Faults are important adjuncts in reference to ordinary and natural drainage. Some are pervious to water, and carry water for long distances where it would least be suspected. Others are impervious, and keep water back. Attention to the structure of a district in this respect is necessary to enable the architect or engineer to understand natural drainage.

The drainage of mines is generally carried on by means of steam engines lifting the water in the mines to the lowest level at which an outfall can be secured to a river or the sea. Coal mines are often enabled to escape much pumping by very carefully shutting out the water met with in sinking; but metal mines cannot generally be thus managed.

Systematic draining on a large scale is essentially a branch of engineering; and we have only noticed the subject in its geological bearings to point out how much one department of science may sometimes be assisted by another.

Dram Timber. The baulk timber that comes from Dram, in Norway, is known under this name in the timber trade.

Drama (Gr. δρᾶμα, *an action or thing done*). A species of poem in which the action or narrative is not related, but represented.

The elements of the dramatic art in Greece were found in the religious festivals celebrated from the earliest ages in that country. The feasts of Dionysus (Bacchus) in particular had sacred choruses or odes; these were afterwards intermixed with episodic narrations of events in mythological story, recited by an actor in the festival with gesticulation. The next step was to introduce two actors with alternate recitation; and thus were produced TRAGEDY and COMEDY [which see]. In the latter, the dialogue of the interlocutors was satirical; in the former, mythological. The early Greek tragedy was a dramatic representation of some scenes or events recorded in the national traditions, the actors personating those who played a part in these events, together with a chorus or band of singers, representing such persons as might naturally be supposed to have been bystanders at the occurrence (captive women, old men, or counsellors, &c.), who sang at intervals, during the representation, hymns to the gods, or songs appropriate to the scenes passing in representation: while the Attic comedy, in its first invention, must be regarded as a parody on tragedy, in which the personages were either real characters introduced for the purpose of satire, or ludicrous personifications. Æschylus, the oldest tragic writer (with the exception of Phrynichus, his contemporary), carried the Greek drama at once to nearly its highest state of perfection. Sophocles and Euripides introduced additional actors into the dialogue (which at first admitted only two at the same tine), and turned the naked recitals of events which form the substance of the plays of Æschylus into something more nearly resembling the modern idea of a plot, with contrasted characters and incidents leading to the accomplishment of a main action. Many tragic writers, the whole of whose works have been lost, flourished after Euripides in Athens and Alexandria; but they do not seem to have altered the character of the art which they received from their predecessors. The fate of comedy was different: the old Attic comedy was a political or philosophical satire in action, which in form was a burlesque on the tragedy. Afterwards, passing through the intervening stage of the middle comedy, of which we know little, the art acquired in the new comedy of Menander and Philemon a character somewhat approaching to that in which it is at present cultivated; a representation of scenes and incidents in ordinary life, of a light or ludicrous character.

From the rules of criticism delivered to us by Greek authors, and especially by Aristotle, it appears that the parts or characteristics of a tragedy, essentially divided, were held to be the fable or story, the manners, the style, the sentiment, the music, and the diction: that the fable should consist of an entire action, namely, one principal event with its auxiliary events; and that the proper emotions to be excited by

the action are terror and pity. Its parts of quantity, according to the division of form, were the *prologue*, being that part of the tragedy which precedes the parode or first entry of the chorus; the *episode*, being all those several parts which are included between the several choral odes; the *exode*, the part which follows the last choral ode; and the chorus itself, or the intervening odes, which also admit of various subdivisions. Formally considered, the arrangement of the old comedy nearly resembled that of tragedy; in the new, the chorus was altogether omitted. The unity of action was a remarkable characteristic of the Greek drama; but it should rather be termed unity of subject, inasmuch as in many of our remaining tragedies, and especially those of Æschylus, there is little or no trace of what we term a *plot*, i. e. a main incident at which we arrive through subordinate incidents tending to its accomplishment. The unity of time—viz. that the imaginary duration of the action should not exceed twenty-four hours; and that of place—namely, that the scene in which the events occur should be the same throughout—are inventions of French critics, not warranted by the remains of Greek art, in which both are not unfrequently violated; but, although not rules of Grecian discovery, they are easily rendered applicable to the simple and severe form of the Greek tragedy.

In considering the theatrical effect of the Greek drama, we must remember that the tragedies were originally religious solemnities; the theatre, a vast building open at the top, accommodating several thousand spectators. Dramatic representations were, at Athens, the offering of wealthy men to the people: he who contributed the expenses of the entertainment was said, *εἰσάγειν*, to bring in the play; the poet who produced it, *διδάσκειν*, to teach it, i. e. teach the actors to perform it. A complete representation consisted of four pieces by the same author: a *trilogy*, or three tragedies, continuing the same subject; and a fourth piece, termed a *satyric drama*, of which the chorus consisted of satyrs, and the subject was treated in a manner approaching to burlesque. The features of the actors were exaggerated by masks, their height increased by dress, and their powers of voice aided by acoustic contrivances, in order to suit the colossal dimensions of the theatre. The whole vocal part was rhythmical; the choral odes were sung, and accompanied by the choric dance, in which the actors composing the chorus took part, subjected to very peculiar rules: the narrative part of the performance was spoken in a peculiar modulated voice, resembling probably the recitative of the modern opera.

Latin Drama.—The early Etruscans possessed dramatic representations, whence the Romans derived some peculiar national entertainments [MIMI]; but, with this slight exception, their drama consisted merely in the first instance of translations, afterwards of close imitations of the Greek. In the degeneracy of the Roman empire even this adscititious taste ceased to be cultivated, and the theatres were entirely occupied by farcical buffoonery, or shows and sports on a gigantic scale. Among an infinite variety of works which treat of the classical drama, may be cited the first volume of Schlegel *On Dramatic Art and Literature.* A catalogue of them will be found at the end of the fourth edition of Donaldson's *Theatre of the Greeks.*

Chinese Drama.—In China, theatrical entertainments form one of the most popular amusements, and theatrical writing has been cultivated from a very early period. The Chinese drama comprises pieces which we should term both tragical and historical plays, tragi-comedies, and comedies both of intrigue and of manners; together with abundance of low, pantomimic, and farcical representations. In their regular drama, however, there appears to be less of what we should term connected than of successive action: many of them are, as it were, dramatised memoirs or biographies of individuals, real or fictitious; the representation of some is said to require ten days. It is remarkable that, of all national dramas, the Chinese appears to be the only one in which we can trace no original connection with religious observance. (Morrison, *Horæ Linicæ*; Abel Remusat; *Memoirs of the Académie des Inscriptions, &c.*)

Hindu Drama.—The Hindu plays which now exist are written for the most part in Sanscrit, although not a living language at the period when they were composed. The dramatic art appears to have flourished in India during a period of several ages, ending about the fourteenth or fifteenth centuries of our era. Dramatic criticism was also much cultivated; and the most minute and artificial rules are laid down by Hindu commentators as to the conduct of a piece, the requisite ethics, the formal arrangement, and the characters which must be introduced. The Hindu drama is so widely different from the Greek or Chinese, that it must be regarded, like them, as a spontaneous offspring of national genius.

Modern European Drama.—For many centuries after the downfall of the Roman empire, the dramatic art appears to have been entirely lost. Its first revival in the middle ages was owing to the solemnities of the church, into which dramatic interludes were introduced in various countries of Western Europe, representing at first events in biblical history or the lives of the saints, and afterwards intermingled with allegorical fantasies. [MYSTERIES; MORALITIES.] At the period of the revival of literature, however, the dramatic art was called into life nearly at once in the four principal countries of Western Europe; Italy, France, Spain, and England. In Italy and France it arose simply classical, and unmixed with any original conceptions, or with the sentiments and fashions of the middle ages; in Spain and England it partook largely of both, and was also immediately derived from the mysteries

and moralities above mentioned: hence, in a historical view, arose the distinction, so elaborately explained by modern critics, between the classical and romantic drama.

Italian Drama.—Originated in close imitation of classical models. The pastoral drama of the sixteenth century, of which Tasso and Guarini were the most celebrated writers, furnished the first novelty in this branch of literature; but these are rather poetical than dramatical compositions. The true national theatre of Italy arose in the seventeenth century, in the musical drama (opera), to which Metastasio, early in the eighteenth, communicated all the charms of poetry; but since the period of that writer, the operatic part of the dramatic art has again been wholly disconnected from the literary, and the words only serve as vehicles for the music. While the higher classes were devoted to the opera, the lower found their national amusement in the *commedie del' arte*, comedies performed by masqued characters, which gradually became fixed in the well-known persons of Harlequin, Pantaloon, Brighella, &c., who improvised their parts. Goldoni, in the middle of the eighteenth century, succeeded in establishing a regular comic drama in possession of the stage; while his rival, Gasparo Gozzi, took up the commedie del' arte as models, and founded upon them a series of amusing extravagances. But since the period of these two spirited writers, comedy has fallen almost completely into disrepute. At the end of the eighteenth century Alfieri, a bold and severe genius, produced tragedies in which the ancient classical form (with the exception of the chorus) was again reverted to, instead of the French imitations of it which had long been current in Italy as well as the rest of Europe; and several dramatic poets have since appeared, who have adopted the same model.

French Drama.—The early French tragic writers, from the beginning of the sixteenth century down to Corneille in the middle of the seventeenth, produced nothing but unsuccessful and somewhat barbarous imitations of the Greek tragedy. The first pieces of this kind represented on the French stage had prologues and choruses. The French tragedy grew up with Corneille and Racine as models, and Boileau as its legislator. A peculiar and rigorous system of criticism was introduced, affecting both the form and the substance of dramatic writing; and this system became established in the minds of the French public, as the natural and not the conventional rule of beauty. It would be impossible to enter into an examination of the rules of the French drama; suffice it to say, that they banished from the tragic stage all except heroic characters and passion; required perfect simplicity of plot, uniformity of language, and, in addition, the observance of the before-mentioned technical unities of place and time. These rules have ever since been scrupulously followed, without deviation, on the regular French stage. The French comedy, however, is infinitely more national and characteristic than the French tragedy: it originated in that of Spain, and was carried at once to a high degree of perfection by Molière, retaining satire instead of adventure as its leading principle. Since that period the French comic stage has been, beyond all contradiction, not only the best, but the model from which that of all other nations has been wholly derived. Of the present state of the French drama it is difficult to speak with precision; but the national or regular stage seems to be every day losing in popularity, while the attempts to establish a new one on what is termed in France the romantic model have hitherto met with very partial success.

Spanish Drama.—Spain commenced her literary career more independent of foreign aid than any other country. Her dramatic art appears to have originated as early as the fourteenth century, which produced satirical pieces in dialogue, and one complete dramatic romance by an unknown author (*La Celestina*), in addition to the mysteries and miracle plays, which were exhibited in Spain even more plentifully than elsewhere. The early Spanish comedies of the sixteenth century were conversations like eclogues, between shepherds and shepherdesses; with occasional interludes of negroes, clowns, and Biscayans, the favourite subjects of popular jest. But the Spanish drama owed to one great author, Lope de Vega, what our own owed to his contemporary, Shakspeare—a rise at a single bound from insignificance to great richness and variety. Calderon, a greater poet than Lope, and his equal in dramatic power, is the only other great name in the Spanish drama. Subsequent writers may all be classed as imitators either of their own older poets, or of the favourite dramatists of the French school.

English Drama.—For the semi-religious representations out of which the English drama arose, see MYSTERY and MORALITY. One of the latter, *The New Custom*, was printed as late as 1573; by which time several regular tragedies and comedies, tolerably approaching to the classical model, had appeared. But a third species of exhibition soon took possession of the stage, the historical drama, in which the successive events of a particular reign or portion of history were represented on the stage; and, together with it, arose the English tragedy and comedy. Our first dramatic poets (those before Shakspeare) were scholars; hence they preferred the form of the ancient drama, the division into acts, &c. But they were also writers, who strove for popularity with the general class of their countrymen; hence, instead of imitating classical simplicity, and confining themselves to a peculiar cast of diction and sentiment removed from the ordinary course of life, they invented a species of composition which intermingled poetical with ordinary life and language. Comedy, again, became in their hands a representation of adventures, differing from those of tragedy only

by ending generally in a happy instead of an unhappy exit, and not materially either in the characters or language. Thus the distinctions which they established between tragedy, comedy, and tragi-comedy, are little more than adventitious; and the Shakspearian drama, properly considered, must be looked on as a miscellaneous compound in which actors, language, and sentiments, of a character far removed from those of ordinary life, alternate with those of a low and even a burlesque character. There is no tragedy of Shakspeare in which comic scenes and characters are not introduced: there is only one comedy (*The Merry Wives of Windsor*) without some intermixture of sentiment approaching to tragic. It continued to be the chief national literature, as well as the favourite national amusement, down to the period of the civil wars, when the opinions and legislation of the prevailing party put a stop to dramatic representation altogether. During the interval thus created the old English art was unlearned altogether, and the new drama, on the model of the French, introduced almost at once on the return of Charles II. and his courtiers from the Continent. The distinction between tragedy and comedy was then first substantially recognised: the former confined to heroic events and language, the latter to those of ordinary life. But tragedy, subjected to foreign rules, ceased gradually to flourish; and has never recovered itself. Comedy, on the other hand, obtained possession of the national taste and stage; and although the charm of poetry and romantic adventure, which had belonged to the old drama under either name, was denied to the modern comedy, it soon attained a high degree of excellence as well as popularity. The last comedies in verse were written shortly after the Restoration; since which time, with the exception of a few isolated attempts to revive the older form, it has been entirely framed on the French model. The main element of a modern comedy is satire; but it admits of a subdivision into comedy of intrigue and comedy of manners — the former being chiefly directed to the developement of a plot, the latter to the delineation of manners; although these qualities ought, properly speaking, to be united to constitute a good play. The most distinguished of our dramatic writers in the former line are, amongst many, Congreve, Vanbrugh, Farquhar, Colman, Sheridan: in the latter, the writings of Shadwell and Foote, perhaps, afford the most remarkable instances of that less popular form of comedy which almost neglects the interest of plot, and confines itself to a satirical representation of prevailing vices and follies. (*Edinburgh Review*, vol. xxxviii.; *Prolegomena to Malone and Boswell's Shakspeare*; Hazlitt's *Lectures*; Coleridge's *Remains*; Collier, *History of English Dramatic Poetry*.)

German Drama. — The modern German drama is founded on the old English model; and, although the last in order of time, has risen to a high degree of excellence, the stage in Germany having been more recently national and popular than in other European countries. While France, England, and Spain have to look back two hundred years for those names which form the glory of their dramatic literature, Lessing, Schiller, and Goethe are writers only of the past century.

Dramaturgy (Gr. δραματουργία). The science or art of dramatic poetry and representation; a word used by German writers.

Drapery (Fr. drap, *cloth*). In Painting or Sculpture, the clothing applied to the human figure is known by the name of *drapery*.

Drastic Medicines (Gr. δραστικός, *effective*). A term chiefly applied to purgatives and some other remedies which are rapid and powerful in their operation.

Draught of Water. The depth of the lowest point of the ship: as the keel is seldom exactly horizontal, the draught of water is taken forward and aft. A ship of the largest size draws nearly thirty feet.

Draughts. A game of great antiquity. An ancient papyrus, preserved in the Museum of Antiquities at Leyden, represents a man playing this game alone; but it is now always played by two persons on a board marked as for chess, with black and white pieces respectively. As these pieces were intended to represent a combat between two armies, they were called by the Romans milites, *soldiers*, hostes, *enemies*, and latrunculi, *robbers*. Among the Greeks the game was known by the name πεσσοί. Herodotus (i. 94) distinguished it from κύβοι, or the game of dice, which was, however, subsequently combined with the former, which was thus converted into a game of chance like our BACKGAMMON.

'A move at chess or similar game was formerly known by this name [draught], whence the game of draughts, or moves with separate pieces.' (Wedgwood, *Dictionary of English Etymology*, s.v.)

Drawback. In Political Economy. When a duty is laid on an article produced in a country that is suitable for the foreign market, it is usual, on its being entered for exportation, to remit or pay back the duty to the exporter; and hence the technical phrase *drawback*. The policy of a measure of this sort is, in most cases, obvious. It is rarely for the public advantage to impose a duty on an article about to be exported: the inevitable effect of such duty is, by proportionally increasing the price of the article, to lessen the foreign demand for it; and its probable effect is, in most instances, entirely to exclude it from the foreign markets. Except in a few rare cases, one country has seldom so great an advantage over others in the production of commodities as would justify the imposition of a duty on their exportation, without incurring an extreme risk of making them be supplied from some other quarter. This, however, is a result to be deprecated in every point of view. And hence in every case in which the exporting country has no ascertained or decided superiority over others in the production of commodities on which duties are laid at home.

there can be no question as to the expediency of drawbacks. These must not, however, exceed the amount of duty charged; for when they do this, the excess becomes, in fact, a bounty.

Some few articles on which a customs duty is levied are not privileged with drawback on exportation. This is especially the case with corn under the existing duty of one shilling the quarter. The charge is a landing, not a bonding duty. Hence, while such a charge raises the price of all corn sold by the amount of duty levied, it prevents the country from becoming an entrepôt of grain for the rest of the world.

Drawbridge. A bridge erected upon a line of canal or on the approach to a fortification, so that it may be opened whenever it may be desirable to interrupt the communication, either for the purpose of allowing the passage of boats upon the canal, or for the sake of hindering the passage to the interior of the fortification. The same kind of bridge is also largely employed for the service of docks, or other places where the necessities of the traffic are such as to require that the levels of the roadway, over the bridges, should not interfere with those required for the waterway. From the necessities of the case it follows that there must be several varieties of these structures, such as the *lifting*, the *turning*, the *bascule*, or the *rolling* bridges.

The *lifting* bridges are erected when the boats are required to traverse the canal at the level of the roadway, or so near to it as to render it impossible to raise the latter sufficiently to allow them to pass under. If they are not made with a counterpoise to the weight of the platform, the machinery for hoisting them must be calculated so as to allow it to overcome the dead weight. Bridges of this kind are common on the Dutch canals, but they present the inconvenience of requiring that the passage way should be interrupted whenever the bridge is opened; and they also need a large framework to support the upper structure when raised; the roadway moreover hinders the ease of the manœuvres of sailing barges. For fortifications, this kind of drawbridge is commonly used, the roadway forming the gate when the bridge is removed; and the chains are usually made to serve as counterpoises upon the system invented by General Poncelet.

The *turning* bridges are used when it is necessary to substitute for the lifting bridges a structure which would allow the vessels to pass through them with all their standing gear in place, and they have the advantage of being placed at nearly the level of the water. The convenience of these bridges for dock service has produced their universal application in those situations where labour can be obtained easily, and where there is an absolute necessity for keeping the rigging of the ships in its original order. It is for this reason that the *bascule* bridges have been abandoned in the docks where the navigation is very active, for they produce as much interference with the rigging of a ship as the lifting bridges would do. The bascule bridges, in fact, consist of a bridge turning upon a horizontal pivot, with a counterpoise rather in excess of the weight of the roadway; and they are, therefore, made to turn nearly of the precise width of the waterway. The foundations for the counterpoise must also be executed in the best hydraulic masonry; and the great gap thus left in the roadway when the bridge is raised constitutes a very serious objection to this kind of bridge. Many bascule bridges were introduced in the construction of the docks at Hull, and in those of Havre.

The *rolling* bridges have been introduced for the sake of accommodating the traffic upon the docks to the purpose of railways, and they may be described as consisting of a bridge made to move laterally upon a carriage until it has passed the junction of the line of rails, and then to pass inwards so as to leave the water-way clear. They require a considerable foundation, but they are very efficient, and offer no impediment to the navigation; one of the best examples is the bridge erected on the South Coast Railway over the river Arun.

Drawbridge. In Fortification, a movable bridge, used formerly in castles, and now in fortresses, allowing communication across the moat or ditch to be cut off or restored at will by those who hold its moving power.

Drawing. In the Fine Arts, the art of representing any object by means of lines circumscribing its boundaries. Drawing is of course the foundation of everything in art, including within it a knowledge of perspective, anatomy, and proportion, and when acquired giving, as Sir Joshua Reynolds observes, 'a proportionable power of drawing correctly what we imagine.' The human figure is the principal object, upon which a student should be first employed; for he who can correctly draw that will not be at a loss in representing anything else he may wish. Sir Joshua observes, that he who endeavours to copy nicely the figure before him, not only acquires a 'habit of exactness and precision, but is continually advancing in his knowledge of the human figure; and though he seems to superficial observers to make a slower progress, he will be found at last capable of adding (without running into capricious wildness) that grace and beauty which is necessary to be given to his more finished works, and which cannot be got by the moderns, as it was not acquired by the ancients, but by an attentive and well-compared study of the human form.'

In the great age of Greek art, drawing (γραφική) was a regular branch, and considered one of the most essential, of the education of every gentleman. (Pliny xxxv. 36.)

Dreams (Ger. Träume). May be defined to be those trains of ideas which occupy the mind, or those imaginary transactions in which it is engaged, during sleep. The theory of

dreams embraces two distinct classes of phenomena, *physical* and *psychological*: the former relate to the question as to how the body is affected in a state of sleep [SLEEP], how the body in that state affects the mind, and how this affection operates to the production of the phenomena of dreams; the latter, however intimately connected with, and probably dependent on, the former, comprehend an enquiry into the laws which regulate the train of ideas that occur during sleep, and the mode in which these laws operate, together with an examination of certain psychological appearances peculiar to that state. To both these classes of phenomena the attention of some of the most distinguished philosophers, both of ancient and of modern times, has been directed; but there is perhaps no subject on which opinions are more conflicting and unsatisfactory than the theory of dreams. Among a multitude of other *efficient* causes, dreams have been ascribed to direct impressions on the organs of sense during sleep—to the absense of real impressions on the senses—to a disordered state of the digestive organs—to a less restrained action of the mental faculties—to the influence of narcotics or stimulants—to the suspension of volition while the powers of sensation continue—and to the succession and unequal relaxation and cessation of the different senses at the commencement and during the time of sleep. From the remotest ages dreams have also been ascribed to supernatural agency. Dreaming is an operation of the human mind, which, like most others, man shares with the lower animals, who are observed frequently to dream.

Those who wish for comprehensive details on this subject may consult the writings of Aristotle, Lucretius, Democritus, &c.; and, among ourselves, of Locke, Newton, Hartly, Baxter, Beattie, and Steward. For the modern theories on the subject, Professor Bain's work on *The Senses and the Intellect* may be consulted with advantage.

Dredging Machine. A machine for clearing out or deepening the beds of navigable rivers, harbours, canals, &c., by the removal of deposited matters, which are scooped from the bottom in an endless chain of buckets, brought to the surface, and tilted into pontoons.

Dressing. A term applied to gum, starch, and other articles used in stiffening or preparing silk, linen, and other fabrics.

Dressings. In Architecture, mouldings round doors, windows, and other openings on an elevation.

Drift. In Architecture, the horizontal force with which an arch tends to thrust out the piers laterally, is called the *drift*.

DRIFT. The newest accumulations of the upper tertiary period are sometimes thus named. *Drift* is a term best limited to material that has been recently moved by water, and thus includes various sands, marls and gravels, stratified and unstratified, fossiliferous and unfossiliferous, not easily arranged. [GLACIAL DRIFT.]

All the so-called *drift beds* are of comparatively modern date, and they include the remains of animals that have recently inhabited the earth. Among these, however, are many remarkable for their large proportions, which have now become altogether extinct. Their remains are found in gravel and caverns, and are often so far covered up with newer deposits as to prove that there must have been great changes of the earth's surface since they were deposited. There has also been great change of climate. In these drift deposits, human remains have also been found, in sufficient abundance and in a sufficient number of places to render it certain that the human race was in existence contemporaneously with the great bears and hyænas, the elephants and rhinoceroses, and gigantic deer that roamed over the forests of parts of land now European before Europe was a continent. The drift is thus one of the most interesting of all deposits. [BOULDER CLAY and FLINT IMPLEMENTS.]

DRIFT. In Navigation, the angle which the line of a ship's motion makes with the meridian, when she is driven by the wind or waves and not governed by the helm. It also signifies the distance to which she is carried in a given time in that direction.

Drift Currents. These marine currents owe their origin to steady winds, blowing almost constantly towards one quarter, and with nearly equal velocity. In the Atlantic the trade winds cause such currents, but only between the latitudes within which these winds generally blow. The mean velocity of such currents is rarely more than ten miles per day, nor do they extend far below the surface.

In the Pacific, the drift currents produced first by the winds from the antarctic ice towards the equator, and afterwards those crossing the ocean in warm latitudes, are believed to produce the stream current running out from the Indian Ocean round the Cape of Good Hope and ultimately crossing the Atlantic.

Other drift currents less steady and constant are occasionally and seasonally produced by prevailing winds; but as it is only in the Pacific that they have space enough to attain steadiness and important magnitude, it is only in that ocean that they originate stream currents. It is generally considered that the water is elevated on the western side of the Pacific by their agency, and thus has some important influence in commencing the current which, crossing the Indian Ocean, and entering the Atlantic round the Cape of Good Hope, ultimately becomes the Gulf Stream. [GULF STREAM.] However this may be, there can be no doubt that the prevalent winds forming drift currents have some reference to stream currents.

Driftway. A small subterranean gallery, driven in advance of a tunnel; it is the first operation in tunnelling, and everything depends on its being correctly set out.

Drill. In Agriculture, a machine for sowing agricultural seeds in rows; sometimes worked by the hand alone, and sometimes by the addition of a horse.

Drill. A small tool used by engineers and carpenters, &c., which consists of a metal stock that works by a handle, capable of being turned round easily in a fixed stock; the drilling and boring machines have the stock and drill fixed in the vertical direction, and the substance to be operated upon is placed upon a movable table.

Drill Husbandry. In Agriculture, the cultivation of arable land, by sowing the crops in rows; the advantage of which is, that it admits of destroying the weeds, and stirring the soil in the intervals between the lines of plants. This mode of cultivation requires some implements and machines not in use in the commoner kinds of farming; and being besides better adapted for some soils than for others, it is not in such universal use as the obvious advantages attending it would lead us to expect, but it is rapidly gaining ground.

Drip. In Architecture. The same as Corona [which see].

Dripping Eaves. In Architecture, the lower edge of a roof is said to terminate with dripping eaves when they project over the line of the wall, and either allow the water which may fall on the roof to drip or drain off to the ground or to be caught in eaves, gutters nailed under them.

Driver, also called the **Spanker.** In Navigation. A quadrilateral sail hoisted on the mizen gaff, and extended at bottom by a boom. It is the principal 'fore-and-aft' sail; and is of great importance in an adverse wind.

Driving Notes. In Music, such notes as connect the last note of one bar with the first of the following one, so as to make only one note of both. They are also used in the middle of a measure, and when a note of one part terminates in the middle of the note of another; in this case it is called *binding* or *ligature*. [Syncopation.]

Driving Wheel. In Machinery, the term *driving wheel* is given to the wheel which communicates the motion to the pinion, or the second wheel deriving its motion from the first, which may either be a multiplying or diminishing wheel according to the necessities of the case.

Droits of Admiralty. The perquisites resulting chiefly from the seizure of the property of an enemy at the commencement of a war. These are attached to the office of lord high admiral, or to the crown when that office is vacant. They were originally vested in the sovereign, to enable him to provide for the expense of defending the realm, and clearing the seas of pirates; and their value and importance will be at once perceived from the following brief statement. In 1798, one ship which had been captured brought 55,000*l.*; in 1800, another brought 65,000*l.*; in 1804, one captured ship was worth 105,000*l.*; and in 1806, several taken at once netted 155,000*l.* During the French war, also, the Dutch ships at one seizure brought 1,030,000*l.*; the Spanish ships, 2,200,000*l.*; and so large were the sums made at one and the same moment in this rich fund, that the crown one year, after paying many hundred thousands to captors, and large sums to different branches of the royal family, gave a million out of the residue to the public service. By the civil list introduced on the accession of William IV., it was arranged that all the droits of admiralty which might accrue during his reign should be paid into the exchequer for the benefit of the public service; and the civil list of her present majesty has made no alteration in that arrangement. [Prize Money.]

Dromatherium (Gr. *δρόμος, a race,* and *θηρίον, beast*). A genus of fossil mammalia which has been described by Dr. Emmons from the (probably triassic) coal-fields of North Carolina. It appears to have been insectivorous, and nearly allied to *Spalacotherium*. The dental formula is—

$$i.\ \frac{?}{6},\ c.\ \frac{?}{1-1},\ p.\ \frac{?-?}{3-3}\ m.\ \frac{?-?}{7-7},\ \text{total}\ \frac{?}{28}.$$

Dromedary. [Camelus.]

Drop Serene (Lat. gutta serena). [Amaurosis.]

Drops. In Architecture, the frusta of cones in the Doric order, used under the triglyphs in the architrave below the tænia. They are also used in the under part of the mutuli, or modillions of the order. In the Grecian examples of this order, they are sometimes curved a little inwards on the profile.

Dropsy (Gr. ὕδρωψ). An unnatural collection of watery fluid in any part of the body. When it takes place in the cellular membrane, it constitutes *anasarca*; when in the cavity of the abdomen, *ascites*; in the cavity of the cranium, *hydrocephalus*; in the scrotum, *hydrocele*; in the uterus, *hydrometra*; and in the chest, *hydrothorax*. Dropsy may arise from a variety of morbid actions, either of the secerning or absorbing vessels. When the fluid which lubricates the internal surfaces and cavities of the body is secreted in excessive quantity, or is not adequately removed by the absorbents, it may so accumulate as to constitute the various forms of this disease; it may therefore arise out of excessive as well as of defective action: it may also result from a variety of other causes connected with organic lesion or derangement, both vascular and nervous. Any cause obstructing the blood in its return from a part may produce dropsy, and thus we have it as a symptom of various forms of heart and lung disease. Dropsy is also a frequent concomitant of those organic changes in the kidneys known under the general title of *Bright's disease*. The treatment of dropsy will of course vary with the cause of the disease: it sometimes requires depletion, and at others tonics; and local accumulation of fluids is often susceptible of removal by remedies which stimulate the absorbents to increased action, or which excite the excretories of the intestines or promote the flow of urine. Dropsy is a common symptom

of a broken constitution and failure of the powers of life.

DROPSY. In Botany, a disease peculiar to succulent plants, arising from an excessive introduction of water into the system. It produces rapid rottenness, and can be stopped only by destroying all the parts affected, and exposing the plant to a very dry atmosphere.

Droseraceæ (Drosera, one of the genera). A natural order of Exogens, of the Berberal alliance, in which they are known by their regular symmetrical flowers, the stamens alternating with the petals or twice the number, and their parietal placentæ. These curious herbs are found in various parts of the world; the species of *Drosera* being remarkable for the glandular hairs which clothe their leaves, and which each secrete a drop of fluid at the point, so that the plants appear glistening with dew drops. These are called Sundews. *Dionæa muscipula*, called Venus' Fly-trap, whose curious fringed leaves clasp over and imprison any insects which may touch the bristles of their inner surface, also belongs to the order.

Drosometer (Gr. δρόσος, *dew*, and μέτρον, *measure*). Any instrument for measuring the quantity of dew that collects on the surface of a body exposed to the open air during the night. [DEW.]

Drowning. When a person is submerged under water, suffocation ensues, not in consequence of the access of water to the windpipe or lungs, but merely from the exclusion of air; the mechanism of the glottis, or upper portion of the windpipe, being such as to prevent, by the spasmodic closure of the epiglottis, the entrance of more than a very trifling and accidental quantity of water. Under these circumstances, however, an attempt is made to inspire, which is followed by the reaction of expiration, and consequently a little air is thrown out, and the residuary quantity in the lungs still further diminished; access of oxygen to the blood is therefore effectually cut off, the aëration of the blood is prevented, and venous blood circulates in the arterial system, the right side of the heart becoming loaded with it, and the pulmonary vein returning it to the right cavities of that organ. The consequences of the non-aëration of the blood thus ensuing upon the vital functions is the suspension and rapid extinction of the latter; so that in the course of four or five minutes after the access of air has been cut off death ensues, although some of the organic functions may and do continue for a longer period. When therefore a person has been perfectly submerged in water for the space of five minutes, insensibility ensues, and the functions upon which life more immediately depends cannot be restored.

In consequence, however, of the struggles made by drowning persons, and of their chances of occasional gasps of air, and of the varying quantity of air which the lungs may contain, we must not despair of the possibility of resuscitation, even when the body has been for fifteen or twenty minutes in the water, although it must be confessed that after four or five minutes' submersion the chances of recovery are very remote.

The state of alarm and agitation into which persons falling into the water, and who cannot swim, are thrown, and their ignorance in general of the means which should be resorted to upon such an emergency, as well as want of presence of mind to adopt them, lead to neglect of those obvious measures by which immediate dangers might be averted. They should know that the specific gravity of the human body when the lungs are filled with air is less than that of water, and that consequently the body has, under such circumstances, a natural tendency to float; and that if the head can then be so placed as to keep the mouth or even the nostrils above water, respiration may be continued. They should also remember that by a forced inspiration a much larger quantity of air may be drawn into and retained in the lungs than in a common or natural inspiration; and that therefore the blood will continue longer aërated, and consequently a longer period will elapse before a second attempt at inspiration need be made, and before insensibility or the cessation of the vital functions will ensue. If, for instance, while breathing as usual, we suddenly hold our breath, we shall find ourselves forced to make an inspiration in the course of from a quarter to half a minute; but if we previously make two or three forced respirations, so as to cleanse the lungs in the first instance of foul air, and then take a forced inspiration, we shall be able to hold breath for more than a minute, and sometimes even for two minutes. It is upon this principle, that skilful divers are enabled to remain under water for a period that sometimes appears almost incredible; and if the depth of water be considerable, and the air supplied from a diving bell, its degree of condensation or diminished bulk will of course enable a given volume to oxygenate the blood more effectually than the same volume at common atmospheric pressure.

Such, then, is an outline of the physiology of drowning; it naturally leads to the important question as to the most effective means of restoring suspended animation in such cases. It follows from what has been said, in the first place, that not a moment is to be lost in getting the body out of the water, and removing it with the utmost speed to any place where further means can be resorted to; and now air should be thrown into the lungs, and artificial respiration should be attempted with as little loss of time as possible, for till the blood has an opportunity of being aërated, the return of the vital functions is impossible. The body should also be immediately stripped of the wet clothes, which should be cut off or otherwise removed with the utmost speed; warm blankets should be at hand as wrappers, and warm towels for rubbing and drying the body. Artificial respiration, together with warmth and friction, carefully and moderately employed, are the first and most essential remedies. Much has been said of the advantage of

electricity in these cases; and, if possible, it should certainly be resorted to: slight shocks should be passed through the region of the diaphragm, the heart, and along the course of the spine; and various forms of the magneto-electric machine seem particularly well adapted to these purposes. The truth is, that the means to be adopted in all these cases are few and simple; but unless they are immediately at hand, and instantly available, they will fail, even under the most favourable circumstances. Yet, where even a glimmering of hope remains, they should, under any circumstances, be resorted to as speedily and completely as possible; for there are on record extraordinary cases of resuscitation when everything appeared to militate against a successful issue.

But in these cases it is not only important to know what to do, but also what to avoid. Nasal stimulants, such as ammonia, aromatic vinegar, and other pungent and volatile applications should be avoided: they can be of little use under the most favourable circumstances, and in the most judicious hands; and if unskilfully employed, may do infinite mischief. The warm-water bath is a bad substitute for warm air and friction; it interferes with the latter, and with the use of electricity, and places the body in a constrained and unfavourable position. In these days it is scarcely necessary to point out the extreme absurdity of holding the body with the head downwards, to allow the water to run out by the mouth, or the still more dangerous use of tobacco, especially of the injection of tobacco smoke—means calculated to put the life of a healthy person in jeopardy, and every way suited to render all attempts at the restoration of suspended animation ineffectual.

Drugget. A coarse and flimsy woollen texture, chiefly used for covering carpets. It was formerly extensively employed as an article of clothing by the poorer classes, more especially of females; but this and similar fabrics are now almost wholly superseded by cotton goods, which induce greater cleanliness, and are less liable to retain infectious and contagious poisons.

Druids. The priests of the Celtic inhabitants of ancient Gaul and Britain. Some little information respecting them is derived from Julius Cæsar; Strabo, Tacitus, Pliny, Lucan, and other authors, have also mentioned them. On those slender foundations very extensive superstructures have been raised by the imagination of English and French antiquaries. The classical name of Druid was derived by the Latins from δρῦς, an oak; but is more probably of Celtic origin. The doctrine of the Druids was not committed to writing, but retained by memory in the form of verses; of which the Welsh Triads are supposed, with some probability, to retain the form and vestiges. There appears to have been much of fraud and vulgar delusion mixed up in the religious rites which they practised. The gods whom they worshipped, according to classical writers, were Jupiter (Taranis), Apollo (Belenus), Mars (Hesus), and several others, whom they believed to be the same with personages of the Grecian mythology. The sacrifice of human victims is uniformly represented as a part of their worship. Their places of worship were chiefly consecrated groves, of one of which Lucan has given a fine description in the second book of his *Pharsalia*. The rock-altars, cromlechs, cistvaens, and other relics of antiquity, which are scattered over the surface of parts of England and France, are attributed by antiquaries for the most part to the Druidical age. Claudius and other Roman emperors issued severe edicts against the Druids, but did not succeed in extirpating them. This was only effected by the general introduction of Christianity; and some suppose that the celebrated Culdees of Scotland and Ireland were converted Druids. (See the article 'Druids and Bards,' *Edinburgh Review*, July 1863.)

Drum. In Architecture, the upright part of a cupola above or below a dome; it is generally applied to the lower part. The same term is used to express the solid part, or vase, of the Corinthian and Composite capitals beneath the acanthus leaves. Sometimes also this word is used to express each course of stone that is used in the height of a column when it forms a complete section of the cylinder. In works upon machinery, a drum is made to express a hollow cylinder, fixed upon a shaft, for the purpose of driving another cylinder by a band; they may be of any size, multiplying or diminishing, and they may be crossed or plain drums, as the circumstances of the case may require. The advantage arising from the use of drums is, that the machinery to which they are applied works without noise, from the absence of any teeth-wheels or other gearing: the disadvantage lies in the gradual slackening of the *bands*, as the straps which communicate the motion are called.

DRUM. In Music, an instrument of percussion, formed by stretching a piece of parchment over each end of a cylinder formed of thin wood, or over the top of a cauldron-shaped vessel of brass; the latter is hence called a *kettle drum*. The large drums which are beaten at each end are called *double drums*, and are used chiefly in military bands. Small drums, hanging by the side of the drummers, and beaten with great rapidity, are called *side drums*. Kettle drums are always used in pairs; one of which is tuned to the key-note, the other to the fifth of the key. The drum is principally used for military purposes, especially for exciting the soldiers under the fatigue of march or in battle. The drum is supposed to be an Eastern invention, and to have been brought into Europe by the Arabians, or perhaps the Moors. The kettle drum, the bass drum, and tambourine are common in the East.

Drum of the Ear. [EAR.]

Drummond's Light. The name given to the light produced by directing a stream of oxygen gas passing through the flame of alcohol upon a small ball of quick lime. The light

produced by burning lime in this manner is of extreme intensity, and Lt. Drummond, of the Engineers, while engaged in the trigonometrical survey of Ireland, suggested its use as a signal for the observation of distant stations. For this purpose the ball of lime, about a quarter of an inch in diameter, was placed in the focus of a parabolic mirror, the axis of which was directed to the point from which the observation was to be made; and such was the brilliancy of the light that it was sometimes distinctly seen, even in hazy weather, at a distance of upwards of sixty miles, when argand burners and other modes of illumination previously used were altogether ineffectual. But the use of this signal is found to be attended with some inconveniences, and the heliostat is now generally preferred in geodetical operations. (Lieut. Drummond's paper in the *Phil. Trans.* for 1826.)

Drupaceæ (Lat. drupus, its fruit being a *drupe*). One of the orders into which Lindley divides the *Rosaceæ*, and equivalent to a sub-order of that family in the estimation of some other botanists. Its peculiar features are polypetalous regular flowers, a solitary carpel whose style proceeds from the apex, and a drupaceous fruit. The Cherry, Peach, Plum, and Apricot furnish examples.

Drupe (Lat. drupus, *ripe and ready to fall*). In Botany, a one-celled, one or two seeded, superior indehiscent fruit, the outer coat of which is soft and fleshy, and separable from the inner or endocarp (stone), which is hard and bony; as in the Peach and Cherry.

Druses. A people inhabiting the mountains of Lebanon, and the coast from Gibail to Saide, and eastward as far as Baalbec. In religion they pass among the MARONITES [which see] for atheists. The great body of the people are certainly indifferent to any religious forms; but a certain sect, styling themselves Okkals, or Spiritualists, make extravagant claims to purity. The Druses are noted for their hospitality; but their resentment is easily roused, and this characteristic was artfully used by the Turkish authorities in fomenting the recent massacres of the Christians in Lebanon.

Dry (Sax. drig). In Painting, a term applied to a picture in which the outline is too strongly marked, and the colours of the objects do not unite with those by which they are surrounded. In Sculpture, it is used in speaking of a work wherein there is a want of luxuriousness and tenderness in the forms.

Dry Area. An enclosure constructed before a wall, sunk below the level of the ground, for the purpose of intercepting the passage of the water from the outside of the building. It is usually formed by a retaining wall with cross buttresses so built as to maintain an efficient ventilation.

Dry Distillation. This term is applied to the distillation of substances *per se*, or without the addition of water; thus, if we put wood into a retort or other distillatory apparatus, and subject it to heat, it yields tar, vinegar, water, and various gaseous and other matters, which are called the products of its *dry* or destructive distillation.

Dry Rot. A disease which attacks wood, rendering it brittle, and destroying the cohesion of its parts. It occurs among the timbers of ships, where it sometimes commits the most serious damage; and also in damp ill-ventilated houses. It is usually ascribed to the attacks of fungi, especially to such as *Polyporus hybridus*, *Thelephora puteana*, and *Merulius lachrymans*, whose filamentous spawn or thallus appears upon the surface, overspreading it like a tough thick skin of white leather; and there is no doubt of its being often connected with the appearance of such fungi. But dry rot is certainly, in some cases, to be traced to the presence of fungi of a more simple kind.

The destruction of timber by such plants is effected in part by the disintegration of the tubes of the wood, in consequence of the introduction between them of the fine filamentous spawn of the fungi, and in part by the dampness which is thus conveyed to the interior of the wood, where it soon produces decomposition. Dry rot, however, is not always caused in this manner. On the contrary, the term appears to be frequently applied to cases of spontaneous decomposition of timber without the presence of fungi, or when the appearance of the latter takes place long after the commencement of the disease.

When dry rot produced by fungi has once made its appearance, there is no means of arresting its progress without removing the whole of the diseased and neighbouring parts; and even then it will probably again break out, unless means can be taken to introduce a circulation of fresh air among the parts liable to the affection. For if timber is allowed to remain in a damp situation, and in the dark, it affords so favourable a nidus for fungi, that they are almost certain to vegetate upon it, unless some means have been previously taken to render the timber permanently unsuited to their growth. This end has been attained by a process called *kyanising*, which consists, so to speak, of pickling timber in a solution of corrosive sublimate. Various preparations of coal-tar, and its volatile oils, creasote, and similar products, are also effective in preventing dry rot.

Although dry rot generally fixes itself upon timber, it will also attack other matters. The paper hangings of rooms are occasionally overrun by it in houses which have been long shut up and neglected; the different appearances in these cases being produced by the special circumstances under which the fungus is developed, or by the species of fungus itself.

Dryads (Gr. δρυάς). In the Heathen Mythology, nymphs whom the ancients believed to inhabit the woods and groves.

Drying Oil. This term is generally applied to linseed and other oils which have been heated with oxide of lead; they are the bases of many paints and varnishes.

Dryobalanops (Gr. δρῦς, *an acorn*, and βάλανος, *oak*). A tree of the *Dipteraceæ* found in Sumatra, and known by its calyx having a cup-shaped tube and a five-cleft leafy limb, and by its three-valved capsular fruit being enclosed within the cup of the calyx. This tree, *D. Camphora*, furnishes a liquid known as *camphor oil*; while solid camphor is found in cavities of the wood.

Dryopithecus (Gr. δρῦς, and πίθηκος, *ape*). A genus of fossil long-armed apes, which was discovered at Sansan in the south of France, and of which evidences have since been discovered at Eppelsheim, in Germany. It has been conjectured from its dentition that it presented more affinity to the human race than any other monkey, living or fossil; but the conclusion is more probable that it was merely a species of Gibbon, allied to the *Hylobates* which are now found in India.

Drysalter. A dealer in salted or dried meats, and in the materials used in pickling, salting, and preserving various kinds of food; hence drysalters usually sell a number of saline substances and miscellaneous drugs.

Drystove. A glazed structure for containing the plants of dry arid climates; such as the cactuses, mesembryanthemums, aloes, and other succulents of Africa.

Dual Number. In Grammar, the name given to that form of the verb and substantive by which, in the ancient Greek, Sanscrit, and Gothic, and the modern Lithuanian languages, *two* persons or things are denoted, in contradistinction to *plural*, which expresses an indefinite number of persons or things.

Dualism. A name given to those systems of philosophy which refer all existence to *two* ultimate principles. Dualism is pre-eminently an Iranian or Persian doctrine, which may be traced to the mythical phraseology of the Vedas on the daily struggle of light and darkness. Thus Ormuzd and Ahriman answer to the Indra and Vritra of the Vedic hymns. These names themselves recur in the Zoroastrian books. Vritra, the serpent or dragon, reappears as Verethra; and Virtrahan, the slayer of Vritra, as Verethragna. So Ahi, the snake, becomes Azi, and with the addition of dahaka, the foe, becomes the tyrant Azidahaka or Zohak, afterwards called also Anromainyus or Ahriman, the spirit of darkness. Among the Greeks, the Orphic poets made the ultimate principles of all things to be Water and Night; by others Æther and Erebus, Time and Necessity, are severally deemed worthy of this distinction. The ancient Greek and Roman mythology was evidently constructed on this principle. (Varro, *De Re Rustica*, i. 2.) In its more philosophic form, the dualistic theory was maintained among the ancients by Pythagoras and many of the Ionian school; among the moderns, chiefly by Descartes. [Ionic Philosophy; Cartesian Philosophy.]

In Theology, the doctrine of the two sovereign principles of good and evil [Manichæism] is also dualistic; and the high Calvinistic theory may be said to be a species of dualism, viz. that all mankind are divided, in the eternal foreknowledge of God, and by His arbitrary decree, into two classes—the elect and reprobate.

Dubbing Out. A term used by plasterers to signify the system of bringing an uneven surface to a plane, or to carry out a series of small projections, by means of tiles, slate, plaster, or such like objects; they are added to the face of the brickwork beneath.

Ducat, Ducatoon. [Money.]

Duck. [Anas.]

Duckbill. [Ornithorhynchus.]

Ductility (Lat. ductilis, *easily led*). This term is almost exclusively applied to that property of certain metals which enables them to be elongated or drawn out into wire. In this respect gold, silver, platinum, and iron, stand at the head of the list. A wire of platinum not exceeding a 30,000th of an inch diameter has been obtained by placing a fine wire of the metal in the axis of a larger wire of silver, then drawing the compound wire in the usual way, and afterwards dissolving off the silver by nitric acid, so as to leave the included platinum filament intact. A grain of gold may be drawn by the usual process into 500 feet of wire. Silver, for the purpose of embroidery, is commonly drawn into wire of 1-500th of an inch in thickness. [Wire Drawing.]

Ducts (Lat. ductus, from duco, *I lead*). Those membranous tubes in the internal anatomy of plants which have conical or rounded extremities; their sides being marked with transverse lines, or rings, bars, or dots, arranged spirally, and being incapable of unrolling.

Ductus Pneumaticus (Lat. *an air-channel*, from Gr. πνεῦμα, *breath*). The air-duct which communicates from the œsophagus to the air-bladder in fishes. It is the homologue of the *trachea* in the higher Vertebrata, which breathe air.

Dudley Rock. A name given to a limestone of the Wenlock series, situated near the base of the upper division of rocks of the typical Silurian district in England. The Dudley rock is the limestone on which Dudley castle is built, and which forms the fine escarpment at Wenlock Edge. It is the rock whence a very characteristic trilobite has been obtained, also known as the Dudley trilobite (*Calymene Blumenbachii*). Many corals, among which is the chain coral (*Catenipora escharoides*), are also characteristic.

Duel (Lat. duellum, *a conflict between two individuals*; in the original use of the Roman word, *between two states*). This word signified originally a trial by battle resorted to by two persons as a means of determining the guilt or innocence of a person charged with a crime, or of adjudicating a disputed right; but in more modern times it is used to signify a hostile meeting between two persons, arising from an affront given by one to the other, and for the purpose (as is said) of affording *satisfaction* to the person affronted.

The practice of the duel, as a private mode, recognised only by custom, of deciding private differences, seems to be of comparatively recent date, and descends by no very direct transmission from the ancient appeal to the judicial combat as a final judgment in legal disputes. That it originated with the feudal system is abundantly clear, if it were only from the fact that in Russia, where that system was never known, the custom of the duel was unheard of, until introduced by foreign officers almost within the memory of the present generation. But it is certain that many antiquarian writers have confused together two very different institutions: the *appeal to arms*, as an alternative for the trial by ordeal or by compurgators, appointed by traditionary usage from the earliest periods of Germanic history; and the *voluntary challenge or defiance*, resorted to for the purpose of clearing disputes involving the honour of gentlemen. This last custom was first elevated to the dignity of an established institution by Philip le Bel of France, whose edict regulating the public combat between nobles bears the date of 1308: the best comment on which may be found in the spirited and accurate representation, by Shakspeare, of the quarrel between Mowbray and Bolingbroke.

The fashion of the public duel seems never to have prevailed to any extent in England. Although the ancient Judicium Dei was so interwoven with our laws that, at a comparatively late era, the whole court of Common Pleas would occasionally adjourn in full term to Smithfield or Bankside, to see the long-contested intricacies of a 'writ of right' brought fairly to issue in a match at singlestick; yet the stern necessity of washing out affronts in blood, whether in open or private quarrel, does not seem to have been strictly adhered to until the latter part of the reign of Queen Elizabeth. Then the imaginations of the young nobles of the court, heated with the favourite study of chivalry, readily adopted the sanguinary practice of foreign realms. At this period appeared the famous *Treatise of Honour* of Vincentio Saviolo—a fierce and punctilious Italian, a fencing master by profession, bred in the wars of Italy, and deeply versed in the science of the public duello, then a favourite theme of reminiscence, although no longer known in practice. This work, published in 1594—now little known save by the famous quarrel in Shakspeare's *As You Like It*, concerning the cut of the courtier's beard, which seems intended as a parody on some parts of it—appears to have been adopted by the gallants of the time as a standing book of reference in all cases of supposed insult. Saviolo resolves all quarrels into the lie—that is, he supposes the original insult to be followed, either expressly or impliedly, by a regular series of replies and retorts, until one or the other party is reduced to give the lie direct; which, like the phrase 'stupid youth' (*dummer junge*), in some German universities, was immediately followed by the appeal to arms.

That ordinary commotioner the lie,
The father of most quarrels in this climate,

appears to have been raised to this 'bad eminence' by Francis the First, the great guide of his day in matters of chivalry, who first gave it as his opinion, that the lie could under no circumstances be brooked by a man of honour. Attendoli holds that the virtue of the insult lies mainly in the word *lie*; and that any circumlocution, however plain, greatly deprives it of its effect. This, however, Saviolo stoutly denies; and maintains that an imputation on the veracity of a party, in whatever words it may be couched, is equally deserving of resentment. The lie, being a matter of so great importance, became the subject of much nice distinction; insomuch that a note to Dr. Moore's *Essay on Duelling* informs us, that they enumerated thirty-two different ways of giving the lie in the latter part of the sixteenth century. Saviolo, however, contents himself with the division into the *lie direct* and *lie circumstantial*, each of which he subdivides into *general* and *special*; besides a fifth sort, which he calls *fictitious* or *sham lies*. These, he says, seem to have originated from the custom that he who receives the lie direct, or last retort, being of necessity the challenger, has the choice of weapons: to gain which advantage it was not unusual for one who sought a quarrel to address his enemy with, 'If you say I am a scoundrel, you are a liar;' by which means they supposed that the latter was put to the necessity of making a direct reply. In opposition to this notion, Vincentio shows divers honourable devices by which an ingenious duellist, when assailed in this manner, may retort on his adversary, so as to throw the burden of the last word on him. Paris de Puteo, a Neapolitan lawyer, is said to have practised chiefly in this branch of business, and to have answered cases on the point of honour put to him from all parts of Europe. Yet, however extravagant the foolery of these early writers may seem on a matter of such serious nature, it must be confessed that, retaining as they did much of the old opinion, refined into a sentiment, respecting the immediate interposition of God in the judicial combat, the true point of honour was far safer in their hands than in the less scrupulous ones of the professed duellists of modern times.

In 1547, Henry II. of France issued an edict absolutely prohibiting the judicial or public combat. This decree was produced by the death of his favourite, La Chataigneraye, in consequence of wounds received in the lists in the presence of Henry himself. By a curious coincidence, the abolisher of one of the grand institutions of the feudal ages was destined, in his own person, to be the cause of the disuse of another: he was slain in a tournament, and that knightly exercise was no longer practised at courts after that melancholy event. The public duel survived some time longer in Italy. Its abolition in France was by no means followed by the good effects which the statesmen of those days probably anticipated from it. De-

barred from public conflict, the gentlemen of France were at the same time freed from its manifold restraints; and private duels, conducted with a ferocity and sanguinary spirit hitherto unheard of, became very prevalent. The wars of religion, prosecuted with a degree of bitterness perhaps unexampled in the history of any nation, added public causes of dispute to those of an hereditary and personal nature. Even the ordinary laws of honour, which seem inseparable from the practice, were neglected. We find in Brantome, that there were duellists who prided themselves on the advantages which they had taken of their antagonists, and were not esteemed the less in society for having done so. Not only had individuals and families their quarrels; we are told that there were regiments in the same service, of which the officers were bound to fight one another whenever they met. The duellist seems to have usurped, with the fair sex, the attentions usually paid to the soldier. We have the testimony of Lord Herbert of Cherbury, himself a vain and cold-blooded quarreller, for the honour in which the ladies of France held the brave Balagny—an ordinary man, in a threadbare doublet and grey breeches, with neither figure, wit, nor fortune to recommend him; but whose testimonials consisted in the fact of his having killed eight or nine of his friends in single combat.

It was about the reign of Henry III. also, that the sanguinary custom of the seconds taking part in the quarrel of their principals seems first to have become established, a custom which only gradually wore out in the beginning of the last century. When such bloody practices were rife in all parts of France, we are scarcely tempted to doubt the extraordinary assertions we find in the writers of those days—that one hundred and twenty gentlemen were killed in duels, in a single French province, in six months; that in the reign of Henry IV. four thousand fell in two years; that this strange species of mania cost France more gentle blood than thirty years of civil war. Henry IV. issued edicts against duelling; Louis XIII. proceeded against it at one time with such severity, that we are told that wounded duellists were dragged at once from the field to the gibbet; but this unwarrantable violence, as usual in such cases, had no effect. The evil at length produced a remedy by its own excess. In the minority of Louis XIV. the duke de Nemours, a prince of the blood, fell, with two of his four seconds, in a quarrel with another grandee of the court. After this deplorable event, many noblemen and gentlemen of undoubted courage entered into a voluntary compact to abstain from duelling. Louis XIV., when of age, approved of their resolution, and seconded it by several edicts. To the honour of this prince, it should be remembered that during the whole of his life he laboured firmly and temperately to correct this abuse, and with no ordinary success. This he effected, not merely by the force of laws, but by exhibiting in his own demeanour, and encouraging in his courtiers, that mixture of dignity with gentleness which most readily turns away wrath and repels insolent familiarity. One of his expedients, however, it must be admitted, seems to our modern ideas not very likely to attain the object proposed. This was the establishment of a court of chivalry—the members of which were the marshals of France—which was to decide on all questions in which a gentleman might conceive his honour to be involved. It is said that this singular sort of arbitration was at first very efficacious; although in Mercier's time (the reign of Louis XVI.) he tells us (as we might naturally suppose) that a person who should have resorted to the court to redress an insult would only have incurred ridicule, in addition to the disgrace of not personally resenting it. After much contest between the Court of Cassation and the inferior courts on the subject, slaying in duel, in France, is now held to be punishable as homicide, under various provisions of the Penal Code. A civil action lies on behalf of the friends of the slain man.

In England, the first attempt made to introduce legislative enactments in aid of the common law for the repressing of duels is said to have taken place in 1713; when, after the celebrated duel of Duke Hamilton and Lord Mohun, a bill for that purpose was brought into the Commons, but lost on the third reading. A provocation or challenge to fight is a high misdemeanour. In Scotland, as late (we believe) as the middle of the sixteenth century licenses for duelling were granted by the crown, and formed a source of revenue: death in a duel without license was murder. (Pitcairn's *Criminal Trials*.) The new codes of Bavaria and Prussia contain a number of provisions, with perhaps too much minuteness of distinction, against duels, challenges, &c. The common punishment is imprisonment for a shorter or longer term.

With regard to more recent times, it may be said that the practice of the duel is rapidly becoming obsolete: lingering most in those countries which adopted it latest. In France the period of the restored monarchy (1815–1848) was perhaps that of all her modern history in which duels were most rife; not only among the military, but among civilians; insomuch that at one period almost all the personages engaged in the Parisian periodical press were accustomed to maintain their opinions by sword or pistol. But since 1848 they have greatly diminished. The same may be said of the more civilised part of the American Union. In this country, a heavy blow was aimed at duelling in the army by the new Articles of War of 1844, rendering it an offence punishable by cashiering. For some years duels, either military or civil, have been almost unheard of. Germany and the eastern parts of Europe, where the fashion penetrated later, seem now to afford the most numerous instances of it.

Duenna (Span. dueña). The chief lady in waiting on the queen of Spain. In a more general sense, it is applied to a person holding a

middle station between a governess and companion, and appointed to take charge of the junior female members of Spanish and Portuguese families.

Duet (Lat. duo, *two*). A piece of music composed for two performers, either vocal or instrumental.

Dugong or **Duyong.** The name of a herbivorous cetaceous animal, characterised by two large permanent incisive tusks in the upper jaw, and four molar teeth above and below, the grinding surface of which exhibits a rim of cement surrounding a slight excavated centre of ivory. The upper lip is beset with numerous strong bristles, and similar ones are found more sparingly scattered over the body. The anterior extremities are fin-like and without nails. The caudal fin is broad, and of a crescentic figure. One species (*Halicore indicus*, Cuv.) inhabits the seas of the Indian Archipelago. A second dugong has also been discovered in the Red Sea (*Halicore tabernaculum*, Rüppell). The fabled mermaid seems to have been founded on the dugong.

Duke (Lat. dux, *leader* or *commander*; the German herzog has the same meaning). The title of duke is said to have originated in the usages of the Byzantine Empire, where it was given to the military governors of provinces. Thence it was borrowed by the Franks, who adopted, in many respects, the titles and distinctions of the empire. Charlemagne is said to have suffered it to become obsolete, but the emperor Louis created a duke of Thuringia in 847. In course of time, according to the usual progress of feudal dignities, the title became hereditary. In Germany the dukes became the chief princes of the empire; this title being proper to all the secular electors and to most of the greater feudatories. In other countries their dignity became merely titular. In Italy and France, dukes form the second rank in the nobility, being inferior to princes; in England they form the first. The title was not known here until the reign of Edward III.; and the word *dux* is used by writers before that period as synonymous with *count* or *earl*. In the eleventh year of Edward III. the dignity of duke of Cornwall was bestowed on his eldest son, Edward the Black Prince. In the year 1351, his third son, John of Gaunt, earl of Lancaster, was created duke of Lancaster for life, furnishing the next instance of this dignity. In neither of these instances, nor in any subsequent one, according to Sir H. Nicolas (*Introduction to the Peerage*, vol. i. p. lxxvii.), was the dignity thus created a dukedom by tenure: it has always remained a personal title only, and descendible according to the limitations of the charter.

Dulcamara (Lat. dulcis, *sweet*, and amarus, *bitter*). The common Woody Nightshade (*Solanum Dulcamara*), the stalk of which is used in medicine to furnish a decoction which is somewhat narcotic and diuretic, and has a bitter-sweet flavour. It has been recommended in chronic rheumatism, and as an alterative in some cutaneous cases, but is not depended upon.

Dulcimer. A musical instrument, seemingly of the wind species, in use among the Jews. It is sometimes applied to a small instrument of stretched metallic wires, beaten with light hand hammers.

Dulcin. A saccharine matter isomeric with mannite.

Dulse. The Scottish name of various rose-coloured *Algæ*, which are occasionally eaten for want of better fare. It is especially applied to *Rhodomenia palmata* and *Iridæa edulis*; while *Laurencia pinnatifida* is known as Pepper Dulse. These weeds are generally eaten raw, but when cooked have an unmistakable sea-twang.

Dumasine. An oily liquid obtained among other products, by distilling acetate of lime: its formula is $C_{10}H_8O$. Named after the celebrated French chemist, Dumas.

Dumbness or **Aphonia** (Gr. *speechlessness*). This term is generally applied to persons who are either born deaf, or become so in early infancy. The consequence of this is, that the organs of speech are never called into due action, their function being at first imitative in respect to sounds, and the numerous muscles of the tongue, glottis, &c., concerned in speech remain inactive; for persons who even in very early life become deaf are not rendered dumb, the organs of speech having been once called into activity, and having acquired their peculiar powers and consentaneous actions. Dumbness may also arise from injury to the lingual nerves, or from great general or local debility; in which case blisters, stimulants, tonics, and other remedies may be resorted to for the restoration of speech. It is remarkable that the loss of the tongue, and even of part of the palate, does not necessarily occasion dumbness: this has happened from disease, and among barbarous nations the tongue was occasionally extirpated; yet cases are on record showing that even under such circumstances speech was in some degree retained; and there is an account in the *Mémoires de l'Académie des Sciences* for 1718 of a girl who was born without a tongue, and yet acquired the faculty of speech. The case of Margaret Cutting, related in the *Phil. Trans.* (1742) by Dr. Parsons, may also be consulted in reference to this subject. These facts throw a curious light on the alleged miracle wrought on the confessors mutilated by Hunneric. (Newman's *Essay on Ecclesiastical Miracles*, prefixed to the translation of Fleury, Oxford 1842.)

Dumus (Lat.). In Botany, a low and much-branched shrub; hence the term *dumose*, applied to a low and bushy plant.

Dunes (A.-Sax. *low hills*). Hills of movable sand, which are met with along the sea-coast in various parts of Great Britain, Ireland, and the Continent. The mode of their formation and progress is exceedingly curious. In various districts the sea deposits on the beach a quantity of fine sand, which is carried forward by the wind till it meets with some obstruction in the shape of large stones, roots of trees, or other obstacles, when it gradually accumulates

into mounds or hillocks, whose general appearance, size, and distribution depend on those of the obstacles to which they owe their existence. When these mounds have attained a certain elevation, they are urged forward upon the land; for, as Cuvier observes, 'le même vent qui élève le sable du rivage sur la dune jette celui du sommet de la dune à son revers opposé.' The direction which they take depends chiefly on that of the wind; and their inroads upon the land are attended by the most destructive effects. One of the departments of France, the Landes, has been nearly overwhelmed by their progressive advance. The quantity of movable sand which the sea annually deposits on that coast has been estimated at upwards of 3,000,000 cubic feet, and its annual progress inland at about 72 feet. In that department the dunes advance in a north-easterly direction; and it has been calculated, that unless their progress be arrested, they will have reached Bordeaux in 1,500 years. During the violent hurricanes which frequently occur in these regions, the whole mass of sand of which the dunes are composed appears to be in agitation; and such is the rapidity with which they then advance, that entire villages, fields, and gardens are almost instantaneously engulfed, and the aspect of whole districts changed within four-and-twenty hours. The progress of the dunes, however, as already remarked, is in general slow and steady. Thus the town of Mimizan, after struggling for more than the fourth part of a century against their encroachments, is now almost buried beneath them; and such have been their destructive effects upon a village in Brittany, that nothing is visible of it except a small part of the church steeple. As will be easily imagined, the means of arresting the progress of the dunes forms an important enquiry. For this purpose various measures have been recommended; but by far the most efficient means hitherto adopted consists in planting close together, so as to form a line of defence against the sand, such trees and shrubs as are known to thrive in a barren soil. This process, wherever it has been tried, has been found not only to fix the dunes, but at the same time to form a simple and secure barrier against all further encroachment of the sand.

Dungiven Crystals. Yellow or smoky Rock Crystal found in detached crystals embedded in the soil at Finglen Mountain, near Dungiven, in Ireland.

Dunkers. A Christian sect which formed itself into a society under peculiar rules in Pennsylvania, in the year 1724. The origin of their name is unknown. They practise abstinence and mortification, under the idea that such austerities are meritorious in the sight of God, and effective, first in procuring their own salvation, and further in contributing to that of others. They form a society strictly connected within itself, and hold love feasts in which all assemble together; but their devotions and ordinary business are carried on in private, nor do they recognise a community of goods. They also deny the endlessness of future punishments; conceiving that there are periods of purgation, determined by the sabbath, sabbatical year, and year of jubilee, which are typical of them.

Dunnage. On Shipboard, the name applied to the loose wood or rubbish placed at the bottom of the hold to raise the cargo either for purposes of ballast, or to keep it dry.

Duodecimal (Lat. duodecim, *twelve*). Proceeding by twelves. The term is given to a rule or operation of arithmetic, by which the contents of any surface or solid are found by multiplying together its linear dimensions, expressed in feet, inches, and lines, and is consequently much used by artificers in finding the contents of their work. The rule is also called *cross-multiplication*, from the manner in which the operation is usually performed, which is as follows: Suppose it were required to find the superficial content of a plank 12 feet $9\frac{1}{2}$ inches long, and 3 feet 7 inches broad. Set down the two dimensions under each other, placing feet under feet, inches under inches, &c., and for the half inch put down its equivalent, 6 lines, as in the following example:—

$$\begin{array}{rrl} 12 & 9 & 6 \\ 3 & 7 & \\ \hline 38 & 4 & 6 \\ 7 & 5 & 6\frac{1}{2} \\ \hline 45 & 10 & 0\frac{1}{2} \\ & 12 & \\ \hline & 120\frac{1}{2}. & \end{array}$$

Now, since the feet are conceived to be units of measure, the inches are so many 12ths of unity, and the lines so many 12ths of a 12th, or 144th parts of unity. The units consequently form the first column, the 12ths the second, and the 144ths the third. Multiplying therefore the first line by 3 feet or 3 units, we get 38 feet, 4-12ths of a foot, and 6-144ths of a foot. Next, multiplying the upper line by 7-12ths, we get first the 6 lines or 6-144ths, multiplied by 7-12ths, equal to 42-1728ths, which is equal to $3\frac{1}{2}$-144ths. Then the 9-12ths multiplied by the 7-12ths give 63-144ths, which added to the $3\frac{1}{2}$ make $66\frac{1}{2}$-144ths, or 5-12ths and $6\frac{1}{2}$-144ths; therefore $6\frac{1}{2}$ is placed in the third column, and the 5-12ths carried on. Lastly, the 12 units multiplied by the 7-12ths give 84-12ths, which added to the 5-12ths make 89-12ths, and this is equal to 7 units or feet and 5-12ths; consequently 7 is placed in the first column and 5 in the second. Adding the two products together, we get 45 feet, 10-12ths of a foot, and $\frac{1}{2}$-144ths of a foot. But in square or superficial measure the 144th part of a foot is an inch; and 10-12ths = 120-144ths; consequently the result of the operation is 45 sq. ft. $120\frac{1}{2}$ sq. in.

The operation is itself much simpler than the description or explanation, which is found embarrassing to beginners; it would therefore, perhaps, be better to reject the rule altogether from elementary books of arithmetic; and, regarding the inches and lines as parts of a foot,

to perform the operation by the ordinary rule of *practice*.

Duodecimo. In Printing, a book is said to be in *duodecimo* (abbreviated 12mo.) when every sheet being six times folded makes twelve leaves or twenty-four pages.

Duodenum (Lat. duodeni, *twelve*). The commencement of the intestinal canal, forming a division, which in some animals is about as long as the breadth of twelve fingers. This term, introduced by the older anatomists, is still applied to that portion of the intestines, though the measure is generally inapplicable.

Duplicate Ratio. The ratio of the squares of two quantities, or the square of their ratio. Thus the ratio of a^2 to b^2 is the duplicate of the ratio of a to b. If there be three quantities in continued proportion, the first is to the third in the duplicate ratio of the first to the second: thus if a, b, c be continual proportionals, that is, if $a : b :: b : c$, then a is to c in the duplicate ratio of a to b.

Duplication of the Cube. A celebrated problem of the ancient Geometry. While a plague was desolating Athens, a deputation was sent to consult the oracle of Apollo at Delos, who returned for answer, that the plague would cease when they had doubled the altar of the god. The altar was cubical; consequently, the problem was to find the side of another cube of twice the solid contents. As this problem requires the solution of a cubic equation, it cannot be solved by elementary geometry; but Hippocrates of Chios reduced it to another; namely, the insertion of two mean proportionals between two given straight lines, a problem which several of the ancient geometers, particularly Archimedes, Eutocius, and Pappus, discovered methods of constructing by means of the higher curves. Among the modern geometers who have not disdained the same enquiry, are the illustrious names of Newton and Huygens. (Montucla, *Histoire des Mathématiques*.)

Dupper or **Dubber.** A globular short-necked vessel made of buffalo's hide, in which castor oil is imported from India. Each dupper holds about 80 lbs. of oil.

Dura Mater (Lat.). A thick membrane enveloping the brain and adhering to the inner surface of the cranium. [BRAIN.]

Duramen (Lat.). The fully formed central layers of the wood of Exogenous trees; what is called in common language the *heart wood*. It is the sapwood solidified by the introduction of various secretions into the interior of the cells or tubes of which such wood is composed.

Duress (Lat. duritia, *hardship*). In Law, is such constraint, either actual or by threats occasioning a reasonable fear, as will invalidate legal acts done by a party suffering it. Duress of imprisonment must be by illegal imprisonment. Duress per minas, by threats, is interpreted to mean such threats as occasion fear of life or limb.

Durio (Malay, duryon). The genus which produces the celebrated Durian fruit. The tree, which is called *D. zibethinus*, is cultivated throughout the Malay peninsula and islands, where its fruit, during the time it is in season, forms the greater part of the food of the natives. The Durian is perfectly unique, combining the most delicious flavour with the most offensive odour. Both the flavour and odour are variously described; but it is said that when once the repugnance to the latter has been overcome, Europeans invariably become extremely fond of it. The unripe fruits are cooked as a vegetable. They are globular or oval, ten inches long, with a hard thick prickly rind, and a few seeds embedded in a firm pulp, which is the part eaten. The genus belongs to the *Sterculiaceæ*.

Dutch Gold. Copper, brass, and bronze leaf is known under this name in commerce; it is largely used in Holland for ornamenting toys and paper.

Dutch Liquid. *Chloride of ethylene.* An oily liquid discovered in Holland in 1795, and obtained by the action of chlorine on *olefiant gas*.

Dutch School. In Painting, this school, generally speaking, is founded on a faithful representation of nature, without attention to selection or refinement. The ideas are usually low, and the figures local and vulgar. Its merit lies in colouring and drawing with extreme fidelity what was before the eye of the artist. The pothouse, the workshop, or the drunken revels of unintellectual boors, furnished its principal subjects. Notwithstanding its deficiency in all that tends to raise the mind, it has acquired the utmost popularity in this country from its admirable imitation, and general perfection in execution. In the earlier centuries the Dutch school had nothing characteristic about it, but was historical and ecclesiastical, like the Italian and German schools; but after the Reformation and the ravages of the Iconoclasts in 1566, it lost the patronage of the church, and acquired a distinctive character. When the painters were no longer required to produce church decorations, they turned their skill to portraiture and to cabinet furniture; and produced the well-known *genre* pictures and landscapes for which Holland has now for two centuries been distinguished. A similar change from the force of example, and in proportion to the subversion of the old ecclesiastical influence, took place in Flanders and other parts of Belgium, but not to such an extent as to change the character of the Flemish school. To mention only a few: the greatest of the Dutch masters, though not the most characteristic, is Rembrandt van Rhyn, for portraits and figures: F. Bol, G. Flinck, F. Hals, and Vanderhelst were also excellent portrait painters; G. Dou, Terburg, Metzu, Mieris, and Netscher were admirable at conversation pieces; Brower, Ostade, and Jan Steen are as distinguished for the low subjects they painted as for the ability displayed in their execution; Ruysdael, Hobbema, Cuyp, A. Vanderneer, Berchem, and A. Both are among the greatest of landscape painters; Ph. Wouverman and Huchtenburg are unsurpassed as battle painters; W. Van-

develde the younger and Bakhuizen excelled in marine pieces; and Willem Kalf, A. Van Utrecht, Van Huysum, and De Heem are unrivalled as painters of still-life and flowers. (Wornum's *Epochs of Painting*, 1864.)

Duties. In Political Economy. [CUSTOMS; EXCISE; TAXATION.]

Duty of an Engine. The mean amount of work that an engine is capable of effecting in a certain time. [DYNAM OR DYNAMICAL UNIT.]

Duumviri (Lat.). A general appellation, among the ancient Romans, given to any magistrates elected in pairs to perform any function or class of functions. The chief Duumviri were the Duumviri Sacrorum, to whom were intrusted the care and interpretation of the Sibylline books. The Duumviri Municipales had almost consular power in the municipal cities. The Duumviri Navales were officers appointed to man, equip, and command the Roman navy.

Dwarf Wall. In Architecture, a low wall, not so high as the story in a building in which it is used.

Dwarfing Trees. Dwarf trees may be produced in three different ways: by grafting on dwarf slow-growing stocks, as, for example, the pear on the quince; by planting in pots of small size filled with poor soil, by which the plant is starved and stunted; and by causing a portion of the extremity of a branch to produce roots, and then cutting it off and planting it in a pot or box of poor soil. This last is the Chinese method, and is thus performed: The extremity of a branch two or three feet in length, in a fruit or flower bearing state—for example, the points of the branches of a fir-tree bearing cones, or of an elm bearing blossom buds—being fixed on, a ring of bark is taken off at the point where it is desired that the roots should be produced. The space thus laid bare is covered with a ball of clay, kept moist by being covered with moss which is occasionally watered. In the course of two or three months in some trees, and of a year or two in others, roots are protruded into the ball of clay. The branch may then be cut off below the part whence the roots have been protruded, and being planted in a pot of poor soil, and kept sparingly supplied with water, it will remain nearly in the same state for many years, producing leaves, and perhaps flowers, annually, but never shoots longer than a few lines.

Dyeing (A.-Sax. deagan). The object of this beautiful art is to fix certain colouring matters uniformly and permanently in the fibres of wool, silk, linen, cotton, and other substances. There are a few dyeing materials which impart their colour to different stuffs without any previous preparation, and these have been technically termed *substantive colours*. By far the greater number, however, of colouring materials only impart a fugitive tint under such circumstances, and require that the stuff to be dyed should undergo some previous preparation, in order to render the colour permanent; that is, capable of resisting the action of air, light, and water. The substance applied with this intention is called a *base* or *mordant*, and must possess an affinity for the fibre of the stuff on the one hand, and for the colouring materials on the other. The mordant often effects another important object, that of changing or exalting the colour at the same time that it fixes it. The principal mordants are alumina and oxide of iron, and these are usually applied in the state of acetates. As an instance, we may mention the mode of dyeing calico by means of *madder*, a decoction of which, if applied to the unprepared goods, would only give them a dirty red tinge, neither agreeable nor permanent. If the calico be previously passed through a weak solution of acetate of alumina, and then dried at a high temperature, and afterwards washed, a portion of the alumina is retained in combination with the fibre of the calico; and when thus prepared and submitted to the action of a hot decoction of madder, and again washed, it comes out a fine red, which is fixed in consequence of the attraction of the alumina for the peculiar principle which gives colour to the madder. If the mordant be oxide of iron instead of alumina, the colour which is then produced is purple; and various shades and colours are obtained by mixing mordants, by using more or less of them, and by applying the coloured solutions in various states of concentration. Sometimes articles are dyed by a similar precipitation of coloured metallic oxides in the fibre; thus yellow is obtained by passing cloth impregnated with acetate of lead through a solution of chromate of potash: a double decomposition ensues, and yellow chromate of lead is precipitated in and combined with the vegetable or animal fibre. Blues are produced by passing the goods previously mordanted with iron through an acidulated solution of ferrocyanide of potassium; these are generally called *chemical colours*, though not in fact more so than the others. Scarlet is produced by the colouring matter either of the cochineal or of the lac insect, and fixed by oxide of tin, and alumina, and heightened by the action of tartar.

The chemical principles of the art of *calico printing* are the same as those of dyeing, but the details are more difficult and complicated; and in consequence of the combination of a great variety of colours upon the same ground, the process is sometimes extremely refined and intricate; so that a rich, varied, and pleasing pattern, thus effectively produced, may be considered as a triumph of practical skill over theoretical difficulties, which is scarcely rivalled, and certainly not excelled, in any other of the arts. It is obvious that calico printing is in the abstract a topical dyeing; and much discrimination and taste are requisite in the contrivance of the pattern, its general design, and the colours in which it is exhibited. In this art the mordants, and sometimes the colours, are applied either by *blocks*, upon which the pattern is designed in relief, or by *copper plates*, which are engraved, or by *cylinders* or rollers. If the aluminous mordant be printed by one

block and the iron mordant by another, and a mixture of the two by a third, and the piece thus prepared be then passed through a madder bath, and properly cleansed and bleached, the colour will only adhere to the mordanted places, and it will be red where the aluminous mordant only has been applied, purple with the mixed mordant, and black with the iron; if the same three mordants be used with a decoction of quercitron bark, the resulting colours will be yellow, olive, and brown; and in this way a great variety of colours may be produced. Sometimes copperplate and block printing are combined; a fine running pattern being printed by the plate or cylinder over the whole surface, which serves as a groundwork, and upon which other figures are printed by blocks. Sometimes the mordant and colour are both applied at once by means of a block, and rendered fixed and permanent by exposing the goods for some time to steam. Some beautiful effects are also produced by printing the pattern upon a mordanted ground with some substance which will *resist* the colour, and so produce a white pattern upon a coloured ground. The same effect is sometimes brought about by *discharging* the colour by the topical application of certain bleaching materials.

Dyke. The material filling up a wide gap or fissure in rocks. The fissure may have been caused by contraction or during elevation; but if filled up by foreign mineral matter, either distinctly igneous or metamorphic, it is called a *dyke*. A dyke differs from a FAULT in not involving a shifting of the opposite sides of the crevice. The material filling up dykes is often crystalline and porphyritic. In Cornwall such a belt is called an *elvan*, and is often hard, compact, and of some thickness. Elsewhere the dyke will be greenstone, or ancient lava, or quartz rock. The porphyritic dykes in mining districts generally produce a marked influence on the value of the mineral veins. They more frequently injure than improve the vein, and if rich are generally valuable for a different metal than the one mixed in the adjacent country.

Dynactinometer (a word coined from Gr. δύναμις, *power*; ἀκτίς, *a sunbeam*; μέτρον, *measure*). An instrument for measuring the intensity of the photogenic (light-producing) rays, and computing the power of object-glasses. It is described by Mr. Claudet in the *Philosophical Magazine* for June 1851.

Dynam or **Dynamical Unit.** For the purpose of measuring or comparing the moving power of machines, or the useful effect procured by the exertion of animal force applied in different ways, it is necessary to adopt some standard, or unit of force, and for convenience of explanation it is desirable that the unit should be designated by an appropriate name. When the steam engine came into use, the work accomplished by it in a given time was naturally compared with that of the moving power which it most frequently superseded; hence the term *horse-power*, which was originally used by Watt to denote, in a rough way, the force developed by a horse of average strength drawing a load during twenty-four hours without intermission. Watt subsequently gave a definite signification to the term, by defining it to be the force which suffices to raise a weight of 32,000 lbs. avoirdupois to the height of one foot in one second of time. C. Dupin, in his *Géométrie des Arts et Métiers et des Beaux-Arts*, proposed the term *dyname* to denote the unit of moving force, represented by one cubic mètre of distilled water at its maximum density raised to the height of one mètre in an astronomical day. Dr. Whewell, in his *Mechanics of Engineering*, recommended the adoption of the English synonym, *dynam*, to represent the effect equivalent to a weight of one pound raised to the height of one foot in a second. The terms *efficiency* and *duty* are frequently employed in a similar sense.

Dynameter. In Optics, an instrument for measuring the magnifying power of a telescope. The magnifying power is the ratio of the solar focal distance of the object-glass to the focal distance of the eye-piece considered as a single lens; and this ratio being the same as the ratio of the diameter of the aperture of the telescope to the diameter of its image or disc formed at the solar focus, and seen through the eye-piece, the object of the instrument is to measure the exact diameter of this image, which can be either projected on mother-of-pearl or measured by optical means. Ramsden proposed for this purpose the double-image dynameter [MICROMETER], an instrument formed by dividing the eye-lens of a positive eye-piece into two equal parts, and mounting them so that the divided edges are made, by means of a fine screw-apparatus, to slide along each other. Each semi-lens thus gives a separate image; and the distance of the two centres, measured by the revolutions of the screw, when the borders of the two images are brought exactly into contact, gives the distance of the centres of the images, or the diameter of one of them.

Dynamics (Gr. δύναμις, *force* or *power*). This word, which signifies literally the doctrine of force or power, is the name given to that part of Mechanics in which motion is contemplated in connection with the forces of which this motion is the effect. It differs in the last respect from *kinematics*, which is the science of pure motion or change of position irrespective of its cause. Theoretical dynamics is a pure science based upon axioms of its own, which, though *suggested* by experience, are by a process of thought rendered sufficiently general to embrace the laws of natural phenomena. The primary conceptions of dynamics are *space*, *matter*, *time*, and *velocity*. Each of these heterogeneous magnitudes is susceptible of measurement or comparison with an arbitrarily chosen unit-magnitude of its own kind, and thus the science of dynamics becomes based upon that of pure *number*. It is customary in the systematic treatment of the subject to ascend from the dynamics of a single *particle* to that

of a system of particles, or a *body*. In virtue of the law of inertia each particle or mass-element is assumed to be incapable of altering its own condition, whether that be one of rest or of motion; and hence every alteration in the direction or velocity of the motion of a particle is ascribed to the action of *force*, of which latter indeed the alteration of velocity which takes place in the unit of time is considered as a measure. Calling x the distance described by a particle during the time t, its velocity at the end of that time will be expressed by $v = \frac{dx}{dt}$, and the force acting upon it by $f = \frac{d^2x}{dt^2}$, provided it contains the unit quantity of matter. If, on the other hand, its mass be m, then the *moving force* F, as distinguished from the accelerating force f, will be expressed by

$$F = mf = m\,\frac{d^2x}{dt^2}.$$

Such are the relations between the elementary conceptions of dynamics. The manner in which they are applied to the problem of the determination of the motion of a system of particles may, to some extent, be understood by a reference to the article D'ALEMBERT'S PRINCIPLE, but cannot, of course, be adequately explained here.

The science of dynamics is wholly of modern growth, and its foundations were laid by the celebrated Galileo. Before him no one had considered the forces which act on bodies, excepting in the case of equilibrium; and although the acceleration of falling bodies, and the curvilinear motion of projectiles, had been attributed to the constant action of terrestrial gravity, no one had yet succeeded in determining the laws of these common phenomena. Galileo first made this important step in advance, and thereby opened a new and boundless field for the progress of mechanics. Huygens added to Galileo's theory of the acceleration of falling bodies the theories of the motion of pendulums and of centrifugal forces, and thus prepared the way for the great discovery of universal gravitation. In the hands of Newton mechanics became a new science; and the discovery of the infinitesimal calculus at length enabled geometers to express all the laws and circumstances of the motion of bodies by analytical equations. The investigation of the forces which produce the phenomena of the material world, or of the mutual action of the different parts of matter on each other, now forms indeed one of the principal objects of mathematical studies. The best systematic treatises on dynamics are to be found in Lagrange's *Mécanique Analytique*, and Poisson's *Traité de Mécanique*. Besides these there are several excellent elementary treatises on the subject. Mr. Cayley's report on the 'Recent Progress of Theoretical Dynamics' (British Association 1857) may also be mentioned as a valuable work of reference.

Dynamometer (Gr. *δύναμις*, and *μέτρον, a measure*). An instrument to ascertain the force exercised by a steam engine, or any other motive power, which consists of a series of springs or levers, that are made to act by the force of the engine disconnected with any other machinery. General Morin invented the dynamometer that is now generally used for the purpose of measuring the duty of engines, water-wheels, windmills, or horse-engines.

Dynastidae (Gr. *δυνάστης, a master*). A family of beetles, including the giants of the Coleopterous order. They are remarkably powerful insects, excavating burrows in the earth and also in putrescent timber, on which they principally feed.

Dynasty (Gr. *δυνάστεια*, from *δυνάστης, a lord or chieftain*). A race or family of sovereigns in succession.

Dysaesthesia (Gr. *δυσαισθησία, insensibility*). Impaired sense of touch.

Dysentery (Gr. *δυσεντερία*; from *δυς*, and *ἔντερα, bowels*). A disease of the bowels, endemic in many climates in the autumnal months, and frequently arising from marsh miasma, bad diet, exhaustion and fatigue: its symptoms are loss of appetite, sickness, pain about the bowels, and a frequent ineffectual desire to evacuate their contents, which when passed are mucous, fetid, and bloody, with small indurated lumps. It is often accompanied by intermittent and remittent fever, especially in hot and damp countries. In this country dysentery is generally a mild disorder, and not infectious; and is commonly cured by gentle aperients, such as castor oil, or salts and manna, to cleanse the bowels, and opiates to allay irritation. The chronic symptoms which remain are treated with mild tonics, especially vegetable bitters, such as infusion of calumba, cusparia, or cascarilla. The contagious dysentery of camps, attended by remittent or typhoid fever, is an alarming and fatal disease; its treatment requires much consideration and skill, and consists in judiciously meeting the various symptoms as they arise. Diaphoretics and nauseants, especially ipecacuan, succeeded by tonics, are leading remedies; and the febrile symptoms must be treated according to their inflammatory or putrid tendency.

Dysodile (Gr. *δυσώδης, fetid*). A combustible mineral found in secondary limestone, at Melili near Syracuse, in Sicily, of a yellowish or greenish-grey colour, either compact or in foliated masses which are composed of paper-like and flexible laminae, with impressions of fishes and plants. It is extremely fragile, emits an argillaceous odour when breathed on, burns with a crackling noise, giving off much flame and smoke, and a very fetid smell, whence has originated the name *Stercus Diaboli* or *Merda del Diavolo* which is given to it in Sicily. It is also found in France at Château Neuf, Dept. of the Rhône; Saint-Amand in Auvergne, and near Narbonne. It has also been discovered lately by Mr. Charles Gould in Tasmania.

Dyspepsia (Gr. *δυσπεψία*). Indigestion. This is a complaint from which few entirely

escape. It assumes an infinite variety of shapes and symptoms, and arises from many causes. In the higher ranks of society, and amongst the luxurious and opulent, it is a common consequence of over-eating, or of indulgence in not easily digestible or over-stimulating food, or of want of due exercise and general bodily and mental exertion. In others it results from mental anxiety and labour associated with a sedentary life; from the fatigues of business, or the influence of debilitating passions. In the lower orders it is the constant result of indulgence in spirituous liquors, combined in many instances with want of proper food, the means which ought to be applied to procuring it being disposed of in the gin shop.

The symptoms of dyspepsia vary, therefore, in the different grades of life. The epicure loses his relish for the most refined dishes, becomes bloated, plethoric, heavy and perhaps apoplectic; the lady of fashion suffers from headaches, flatulence, occasional giddiness, and dimness of sight; she becomes indolent, capricious, and full of fancies, or, as the old physicians used to say, she has the *vapours*; the studious man feels the intensity of his mind blunted, loses his appetite, or at least all enjoyment of meals, sleeps ill, and dreams much, gets whimsical and discontented with himself and his friends, and becomes a *hypochondriac*; the lower classes at first take their glass of gin or of rum because they find it a cheap stimulant, little thinking of the misery they are laying up for future years; this stimulation soon becomes habitual, and they not only feel miserable and heartbroken without it, but the single glass soon loses its efficacy, and the dose must be gradually increased till they degenerate into regular tipplers, whose aspect may be daily and hourly studied in those dens of iniquity, the gin shops of London, where it is curious and instructive, but humiliating and alarming, to witness the various grades of mental and bodily disease in men, women, and even children.

Complicated as are the symptoms of dyspepsia, and numerous as are the remedies and modes of treatment proposed for its relief or cure, they really resolve themselves into a few simple rules. In the majority of cases, *abstinence* is the first and most essential step: the epicure must abstain from the luxuries of the table, eat and drink with moderation, rise betimes, and use due exercise; the woman of fashion must revert to regular hours, that is, the night and the day must be employed as intended by nature, and not in inverted order; the philosopher and the scholar must occasionally, and often frequently and assiduously, divest themselves of their mental labours, and resort to amusements and occupations of a more trivial character. Those among the lower orders who have once acquired the habit of dram drinking are incurable; for such is the depression of mind and body, and such the gnawing restlessness which a want of the accustomed stimulus occasions, that without it they become miserable and inconsolable, and usually fall a sacrifice to mental or bodily disease, or to both combined: here, therefore, prevention is the only cure. The medical treatment of dyspepsia generally resolves itself into that of such of its particular symptoms or consequences as are most prominent; the inactivity of the bowels is to be opposed by proper aperients properly administered; the debilitated stomach to be strengthened by mild tonics, antacids, and stimulants. The mental symptoms often yield to the same treatment, and often require local depletion, or diffusible stimulants, such as ammonia and ether; and lastly, change of air, of scene, and of occupation are often indispensable, under which head sea-bathing and courses of mineral waters may be included. The above observations are of course inapplicable to all cases of dyspepsia resulting from structural disease, which, though often an effect, is also a frequent cause of symptoms of indigestion: indeed, such are the sympathies of the stomach that it is apt to be affected by any aberration from health.

Dysphagia (Gr. δυς, and φαγεῖν, *to eat*). Difficulty of swallowing. Paralysis, stricture of the œsophagus, enlarged tonsils, relaxed uvula, a debilitated state of the muscular coat of the pharynx and œsophagus, spasm of the organs concerned in deglutition, and inflammation, are among some of the leading causes which occasion difficulty of swallowing; it is also an attendant upon hysteria, hypochondriasis, tetanus, trismus, and hydrophobia. The treatment will depend upon the prevailing case, and is noticed under other articles.

Dyspnœa (Gr. δύσπνοια). Difficulty of breathing. This is generally a symptomatic affection, and commonly attends upon various morbid affections of the lungs, heart, &c. Effusion of fluid into the pleural or pericardial sacs is a common cause of the symptoms during the progress of many forms of dropsy and other diseases. It occasionally happens that persons in full health are seized with an attack of difficulty of respiration; where this occurs in nervous irritable habits, it generally goes off by perfect quiet, with the help of a little ether or ammonia; if in full habits, bleeding is sometimes requisite. Persons who are subject to these attacks should keep themselves as quiet and tranquil in body and mind as possible, and should avoid excess of food and wine, and even all stimulating diet. A recumbent posture, and sudden change of air—as going out of a warm into a cold room, or into the open air—will often relieve an accidental attack of dyspnœa.

Dysuria (Gr. δυσουρία). Dysury. Difficulty in voiding the urine. A common symptom in cases of gravel, inflammation of the urinary organs, spasm, and stricture. The nature of the relief must depend upon the exciting cause.

E

E. The fifth letter in the Hebrew alphabet and in those derived from it. In the Latin language it is often interchanged with *i* and *o*; and in the Greek with *a*, *o*, and occasionally *u*. In most languages *e* admits of great variety in its pronunciation, and, in French and English particularly, surpasses every other letter of the alphabet in this quality: as a Latin numeral E signifies 250—

E quoque ducentos et quinquaginta tenebit.

E. In Music, a note of the scale, corresponding to the *mi* of the French and Italians.

Eagle (Fr. aigle; Lat. aquila). In Heraldry, a bearing of frequent occurrence, and particularly assumed by sovereigns as the emblem of empire, from having been borne on the legionary standard of the ancient Romans. The eagle of Russia is *or*, with two heads displayed, sable, each ducally crowned of the field; the whole imperially crowned, beaked, and membered, gules. The eagle of Austria is also displayed with two heads; the Prussian eagle has one only. The Americans have adopted an eagle of a peculiar species belonging to their continent as the device of the Union, which is impressed on their gold coins.

Eagle. In History, the symbol of royalty; as being, according to Philostratus, the king of birds. The eagle was borne as a standard by many nations of antiquity. The first who assumed it, according to Xenophon (*Anabasis* i. 10), were the Persians; it was used by the Romans at an early period of their history, but first adopted as their sole ensign in the consulate of C. Marius. (Pliny x. 4.) Before that time they had used as standards wolves, leopards, eagles, and other animals, indifferently. The Roman eagles were gold or silver figures in rilievo, about the size of a pigeon; and were borne on the tops of spears, with their wings displayed, and frequently with a thunderbolt in their talons. When the army marched, the eagle was always visible to the legions; and when it encamped, the eagle was always placed before the prætorium or tent of the general. The eagle on the summit of an ivory staff was also the symbol of the consular dignity. In modern times Napoleon caused the tricolor flag, which at the outbreak of the first French Revolution had become the standard of France, to be surmounted with an eagle; and thus constituted it the standard of the consular and imperial armies. From this circumstance, and from the almost unprecedented career of victory so long pursued by the French under this standard, the expression *eagles of Napoleon* is often used metaphorically to designate the *armies* under his command. After the battle of Waterloo, the eagle was superseded in France by the fleur-de-lys, the ancient emblem of the Bourbon race. Eagles are frequently found on ancient coins and medals; especially on those of the Ptolemies of Egypt and the Seleucidæ of Syria. An eagle, with the word *consecratio*, indicates the apotheosis of an emperor.

Eagle. In Ornithology. [Aquila; Falconidæ.]

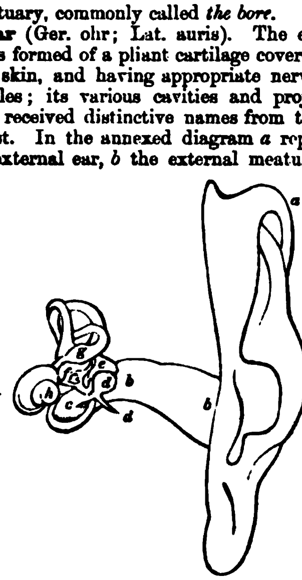
Eagle, Black. A Prussian order of knighthood, founded in 1701; united with the Order of the Red Eagle, or Order of Sincerity, instituted by the margraves of Bayreuth.

Eagle Stone. [Ætites.]

Eagle Wood. The fragrant wood of *Aloexylon Agallochum*, used by the Asiatics for burning as incense. The Malayan name is *Agila*, whence the Portuguese name *Pao d'Agila*.

Eagre. A Norse word, which is used to express the sudden rise of the tide in a river, or estuary, commonly called *the bore*.

Ear (Ger. ohr; Lat. auris). The external ear is formed of a pliant cartilage covered by a thin skin, and having appropriate nerves and muscles; its various cavities and projections have received distinctive names from the anatomist. In the annexed diagram *a* represents the external ear, *b* the external meatus, *c* the



tympanum, *d* the malleus, *e* the incus, *f* the stapes, *g* the semicircular canals, and *h* the cochlea. The curved and irregular passage which leads to the inner ear is called the *meatus auditorius*, and in the adult is more than an inch in length; it is lined with a peculiar secretion called *cerumen*. The *tympanum* separates the external from the internal ear; it is closed by a membrane called the *membrana tympani* or *drum of the ear*, upon the inner surface of which a nerve called the *chorda tympani* ramifies, and to the centre of which is affixed the process of a little hammer-shaped bone, called the *malleus*, and which, together with the *incus*, the *os orbiculare*, and the *stapes*,

forms a chain of communication between the *tympanum* and the *fenestra ovalis*: these small bones are supplied with appropriate muscles. The *vestibule* is a small cavity in the petrous portion of the temporal bone, having a little spiral cavity called the *cochlea* connected with it, and three cylindrical cavities, or tubes, bent in a semicircular form, two of which are horizontal and one vertical. These cavities contain a liquid; and in them the auditory nerve, which proceeds from the fourth ventricle of the brain, ramifies and terminates. It is obvious that vibration of the tympanum, occasioned by undulations of the air, may be communicated through the bony chain above mentioned to the fluid in the vestibule, and thence to the acoustic nerve; but any further uses of this extraordinary and complicated mechanism are beyond our knowledge.

Ear Shell. [HALIOTIDÆ.]

Ear Trumpet or **Hearing Trumpet.** An instrument for aiding defective hearing. The ordinary ear trumpet consists of a metal tube, usually of a conical shape, the wide end being turned towards the speaker to collect the waves of sound, and the narrow end terminating in a small tube, bent sideways so as to enter the ear of the deaf person. Various other instruments besides the *trumpet* are used for the same purpose. The *auricle* is a small scroll-shaped instrument which is worn in the ear, the expanded mouth only being visible. *Ear-cornets* are applied outside the ear, and held in their place by a slender steel spring, a bent tube entering the ear in this case, as in that of the common trumpet. Flexible tubes, made of India rubber covered with silk, and kept open by a spiral spring of wire, terminating at one end in a tube, which enters the ear, and in a cup or hollow hemisphere at the other, into which the speaker speaks, are found to be of great efficiency. *Sonifers* are large bell-shaped instruments of metal, which are placed on a table, and turned towards the part of the room whence the sound proceeds, and the sound being collected at the bottom of the instrument is conveyed to the ear by a flexible tube. With respect to acoustic instruments in general, it does not appear that mathematical accuracy of figure is of much importance. Whatever prevents the dispersion of the undulating air, and directs it upon the tympanum, will partially assist hearing, though, of course, it is advantageous that as much as possible of the sound which enters the instrument should be reflected forward to the ear.

Earings. Small ropes fastened to cringles (loops) in the upper corners, and also to the *leeches* of sails, for the purpose of fixing the leeches of the sail to the yard. The first or head earings fix the corners of the sail permanently, the second being used only in reefing.

Earl (Norse, Jarl). This title denoted at first any person of noble race (Palgrave's *Rise of the English Commonwealth*); and there seem to have remained in popular language traces of this ancient use of the name down to a late period. Afterwards some of the Anglo-Saxon earls were hereditary, and some were official governors of extensive districts. After the Conquest, the title of *earl* was used by the English to express the French title of *count* (in Latin *comes*): to which again the word *graf* (identical in origin with the English *reeve*) furnishes an equivalent in Germany. Hence the wife of an earl is still styled *countess*. In writings earlier than the age of Stephen, the Latin word *consul* is also used as synonymous with *earl*. It has been supposed (and the explanation is supported by Mr. Cruise, *On Dignities*, p. 17) that the dignity of an earl was originally annexed to the possession of a certain tract of land, and that there were three sorts of earldoms—one, when the dignity was annexed to the possession of a whole county with *jura regalia*, in which case the county was a county palatine, as Chester, Pembroke, and Durham; the second, where the earl had no possession of the county, and no advantage from it, but the third penny or third part of the sum arising from pleas in the county court; the third, where a tract of land was granted to hold as a county, *per servitium unius comitatus*. But this is an opinion open to controversy; and it may be doubted whether there are any settled principles as to the creation or descent of earldoms earlier than the reign of Edward III., when they were granted by letters patent to the earl and the heirs of his body. Earldoms, like baronies, gradually became converted from territorial to merely titular honours. These two were the only titles in the English peerage, until the creation of the duchy of Cornwall in the eleventh year of Edward III. (Nicolas's *Synopsis of the Peerage of England*.)

Earl Marshal of England. One of the great officers of state, who regulates ceremonies, takes cognisance of all matters relating to honour, arms, and pedigree, and superintends the proclamation of peace or war. The court of chivalry, *curia militaris* (now almost forgotten), was formerly under his jurisdiction: he is still at the head of the heralds' office, or college of arms. Camden, in his discourse concerning the office of earl marshal, alleges that it was first introduced in the reign of Richard II., who conferred it on Thomas Mowbray, earl of Nottingham, his predecessors having been styled only *marshals* of England. Various limitations have been made in the grants of this office from time to time; but it is now hereditary in the family of Howard, and enjoyed by its head, the duke of Norfolk.

Earnest (Lat. arrhæ, Fr. arrhes). In Law, is a part of the subject of a contract, as money or goods, transferred, in order by such delivery to pass the property in the whole, or in some other way to confirm the contract. By the Statute of Frauds, 29 Ch. II. c. 3, no contract for sale of goods of the value of 10*l.* or more is good unless in writing, or unless such earnest be given or taken.

Earrings (Ger. ohrringe). Ornaments worn by women, and sometimes by men, in all ages and countries. In the middle ages they were termed PENDANTS [which see].

Ears. In Architecture. [CROSSETTES.]

Earth (Ger. erde, Goth. airtha, originally *ploughed land*). The name of the planet which we inhabit. It is the third in order from the sun, its orbit embracing the orbits of Mercury and Venus, but being within the orbits of all the other planets. The earth is endowed with two principal motions; first, a motion of rotation about an axis passing through its centre; and secondly, a motion of revolution about the sun. It is the first of these motions which produces the phenomena of day and night, and the apparent diurnal revolution of the celestial bodies. The time in which the earth's rotation is performed is measured by the interval which elapses between two transits of the same fixed star over the meridian of any place; and this interval is always precisely the same. At all events, astronomers have proved that it cannot have varied so much as three times the thousandth part of a second since the date of the first astronomical observation, that is to say, during the last two thousand years. It is called the *sidereal day*, and forms a perfectly uniform measure of time. [GYROSCOPE.]

The revolution of the earth round the sun is performed in an elliptic orbit, which lies all in one plane, and has the sun in one of the foci. The eccentricity of the orbit, or the distance of the foci from the centre, is 0·01679 parts of the mean distance of the earth from the sun; so that if we take the mean distance for unity, the greatest distance of the sun is 1·01679, and the least 0·98321. The mean distance is nearly 93 millions of miles. The motion of the earth in its orbit is not uniform; being most rapid when it is at its *perihelion*, or point nearest the sun, and slowest at its *aphelion*, or greatest distance from the sun. This inequality of the angular motion of the earth round the sun gives rise to an inequality in the lengths of the *solar day*, the name given to the interval of time between the successive transits of the sun over the same terrestrial meridian. Astronomers, with a view of obtaining a uniform measure of time, have recourse to a *mean solar day*, the length of which is equal to the mean or average of all the apparent solar days in a year. The time in which the earth performs a revolution in its orbit, with respect to the fixed stars, or points in absolute space, is 365·2563612 mean solar days, or 365d. 6h. 9m. 9·6s. This is called the *sidereal year*.

The plane in which the earth describes its orbit is called the plane of the *ecliptic*. The axis of the earth is not perpendicular to the plane of the ecliptic, but makes with it at the present time an angle of 66° 32′ 35·31″; whence the *equator* of the earth is inclined to the ecliptic in an angle of 23° 27′ 24·69″. This inclination, which is called the *obliquity of the ecliptic*, gives rise to the phenomena of the seasons, and to the varying inequality of day and night. In fact, as the two planes intersect always at the centre of the earth, it is evident that if while the earth is carried round its orbit, its axis of rotation remains always parallel to itself, the sun must rise above the equator during one half of the revolution, and fall below it during the other. Now this is what takes place: the earth's axis of rotation preserves very nearly its parallelism, or points without sensible deviation towards the same star during the whole year; and the sun in consequence at one period of the year is 23° 27′ 24·69″ to the north of the equator, and at the opposite season of the year is precisely the same distance to the south of it. The straight line formed by the intersection of the planes of the equator and ecliptic does not preserve the same position on the ecliptic: it has a slow motion *westward*, or contrary to the order of the signs, and retreats at the rate of 50·1″ annually; so that when the sun appears to return to the equator, the sidereal revolution has not been quite completed: there remains an arc of 50·1″. The time in which the sun, or, to speak correctly, the earth, describes this arc is 20m. 19·9s.; consequently the periodical return of the seasons is shorter by 20m. 19·9s. than the true sidereal revolution of the earth round the sun. The revolution of the seasons forms what is called the *equinoctial* or *tropical* year; which, therefore, is equal to 365·2422414 mean solar days; or 365d. 5h. 48m. 49·7s.

The figure of the earth is that of an oblate spheroid of revolution, one of the equatorial diameters being also slightly longer than the other. The equatorial diameters are respectively 41,852,864 and 41,843,096 feet, and the polar diameter 41,707,796 feet. [DEGREE.] Hence, supposing the earth to be a sphere, its whole surface would contain about 196,625,000 square miles.

The *mass* of the earth compared with that of the sun is nearly as 1 to 355,000. Its mean density, which has been ascertained by observing the effect of mountains in deflecting the plumb-line from the perpendicular [ATTRACTION OF MOUNTAINS], and by experiments on the attraction of leaden balls, is to that of water as 5·67 to 1. [CAVENDISH EXPERIMENT.] The centrifugal force at the equator is to that of gravity as ·00346 to 1; and the force of gravity there is such that bodies fall through $16\frac{1}{12}$ feet in the first second of time. If the rotation of the earth were seventeen times more rapid, the centrifugal force at the equator would be just equal to the attractive force, and bodies would have no weight.

The interior of the earth is for the following reasons generally supposed to possess a high temperature:—

1. The form of the earth, nearly spherical, and flattened at the poles of rotation, together with the regular disposition of the materials about the centre in elliptic layers, proves that it must have originally existed in a fluid, if not an aëriform state; so that the constituent molecules must have had free liberty to obey the forces

arising from their mutual attraction and from the rotation of the whole mass, and arrange themselves in the position of equilibrium. But there is no other agent than heat to which we can attribute the fusion of such substances as compose the greater part of the exterior crust of the earth. 2. The phenomena of volcanoes, hot springs, and earthquakes, receive a very simple explanation on the hypothesis that the nucleus of the earth still remains in a state of fusion, and that the consolidation of the exterior crust still proceeds, though at an extremely slow rate. 3. The fact (which now appears to be fully established) that a sensible increase of temperature takes place as we descend from the surface (in deep mines for example), after passing the depth at which the influence of the solar heat ceases to be felt, furnishes a direct proof of a very high temperature in the interior of the earth. Much uncertainty exists as to the rate at which this increase takes place; but the mean result of a number of experiments made in the deep mines of Cornwall, and different parts of France and Germany, gives an increase of 1° of Fahrenheit's thermometer for every fifteen yards of vertical descent, after passing the stratum of constant temperature. Admitting this rate of increase, and supposing it to be continued to the centre, the intensity of heat at the centre will be expressed by 3,500° of Wedgewood's pyrometer. The temperature of 100° of Wedgewood, which is sufficient to fuse the lavas and the greater part of the known rocks, would be found at the depth of 125 miles; but M. Cordier, who, in the *Memoirs of the Royal Academy of Sciences of Paris* (volume for 1827), has collected a great number of facts relative to this subject, is of opinion that the phenomena warrant the conclusion that the mean thickness of the solid crust of the earth does not exceed 60 miles. Professor Hopkins, on the other hand, expresses an opinion, founded on the precession of the equinoxes, that the thickness of the solid crust is much greater.

In whatever manner the earth may have taken its existing form, there are abundant proofs that its surface has been the theatre of many great revolutions. The masses of sand and gravel, and beds of limestone composed of shells and corals, which are found in the interior of continents, and even to the summits of the highest mountains, plainly show that the present land was once immersed deep under the waters of the ocean. The remains of animals and plants belonging to tropical countries, found in the highest latitudes, indicate an entirely different disposition of climates from that which now exists. The appearances of the mineral strata, twisted, and dislocated, and broken asunder, also afford undeniable evidence that the changes which have taken place on the surface of the earth have not all been brought about by the silent action of the causes which we see in daily operation, but by the operation of some sudden and violent force.

Earth. In Agriculture, earths are distinguished from soils by their being without organised matter in their composition. Though scarcely any such earths are found on or near the ground's surface, yet the distinction is of use in speaking of soils. Thus we say a soil, the basis of which is earth, of sandstone, or of chalk, &c.

Earth. In Chemistry, this term is applied to certain insoluble oxides of abundant occurrence in rocks and soils, such as silica and alumina. Lime, magnesia, baryta, and strontia have been called *alkaline* earths, their action on vegetable colours being similar to that of the alkalies.

Earth Currents. [Magnetism, Terrestrial.]

Earth Nuts. Various subterranean substances produced by plants. In England the name is given to the tuberous root of *Bunium flexuosum*, an umbelliferous plant; in Egypt to the round tuber of *Cyperus rotundus*, and other species of the same genus; in China to the subterranean pods of *Arachis hypogæa*, a leguminous plant; and in other countries to similar pods produced by the genera *Voandzeia*, *Amphicarpæa*, &c.; or to the small tubers of Cyperaceous plants.

Earth Shine. [Moon.]

Earthenware. The art of fashioning clay into instruments of domestic use was one of the earliest and most widely diffused of those which the human race has cultivated. Even in the remotest periods, and before the use of metals, the custom prevailed of making vessels of clay, which seem to have been turned upon the wheel as well as baked. The Greek and the Roman form of civilisation produced objects of this description which are but the continuation of the traditions of the stone age; and the savages of the present day manufacture ornaments in the style of their ancestors.

Without endeavouring, however, to trace back the history of this art to the earliest period, it may suffice to mention that the Egyptians and Assyrians appear to have possessed it in considerable perfection; for the paintings on the Egyptian tombs show that the former were acquainted with the use of the potter's wheel; while the remains of pottery show that the Assyrians employed glazes similar to those used at the present day. The Greek earthenware, like all the other productions of that highly gifted race, was marked by an intimate knowledge of the effect of form and outline; and the later specimens of their ware contain illustrations of the other arts, and of the social habits of the times. In the beginning the Greek vases were of a pale yellow clay, with the figures painted in a dark reddish-brown colour; but at a later period the figures were painted by a black glaze, upon a pale or a red ground; the designs being of the most elaborate and beautiful character. The Romans appear to have extended the application of the art to the manufacture of all kinds of articles of domestic use, for the remains of their tile and pottery works are to be met with wherever they possessed the soil. Generally speaking, their ware is of a red colour, arising from the presence of a peroxide of iron in

the paste, and it bears a brilliant glaze. The Moors appear to have taken up the art from the time of the destruction of the Roman empire, and to have introduced the brilliant colours which characterise their productions. From the Moors the Italians seem to have learnt the art of making their ware, which was perfectly manufactured in Majorca, and subsequently on the Italian mainland, at Gubbio, Urbino, &c. Giorgio, Andreoli, and Lucca della Robbia are the great masters of the art; they flourished about the end of the fifteenth and the beginning of the sixteenth centuries. The Gubbio wares were remarkable for their iridescent hue; the other specimens of the so-called Italian majolica are, however, principally remarkable for the purity of their design: for their mechanical execution was very deficient, and characterised an early period of art. The Limoges ware was also of the same kind, though the later productions of these artists were marked by an improvement in the style of handling colours, and to some extent for an improvement in the forms of the objects; but the great step taken by the French artists was the invention of the white glaze by Bernard Palissy. The art of earthenware manufacture was preserved at the establishments of Rouen and Strasbourg, and to some extent in Paris itself; but about the beginning of the last century the Dutch succeeded in winning for their Delft ware a European reputation, which lasted until the latter end of the last century. Subsequently to that period the English have entered the field, and have far surpassed their rivals in the solidity and beauty of their wares. Wedgwood began the improvement upon the old Chelsea china; Chamberlain improved that of Worcester; Turner, that of Derby; while Spode, Copeland, Minton and others, have maintained the excellence of the British ware. The Prussians have of late made great progress in this art, and the Italians have also paid much attention to the factory of the Capo di Monti ware; whilst there have been but few productions from the Spaniards, Portuguese, and Russians, who seem to be content to borrow their arts from their more energetic neighbours.

Earthquakes. Undulations produced in the external film or crust of the earth by some force acting from within tending by a sudden explosion to rend asunder the surface; this result being prevented more or less completely by the elasticity of the matter lying above the seat of disturbance. The result is the production of a wave, which in its transmission along the surface originates the phenomena in question. [VOLCANOES.] Earthquakes are usually preceded by a general stillness in the air, and an unnatural agitation of the waters of the ocean and of lakes. The shock comes on with a deep rumbling noise like that of a carriage over a rough pavement, or with a tremendous explosion resembling a discharge of artillery or the bursting of a thunder cloud; sometimes heaving the ground perpendicularly upwards, and sometimes rolling it from side to side. The single shocks of an earthquake seldom last longer than a minute, but they frequently follow one another at short intervals for a considerable length of time. During these shocks large chasms are made in the ground, from which sometimes smoke and flames, but more frequently stones and torrents of water, are discharged. In violent earthquakes, these chasms are sometimes so extensive as to overwhelm whole cities at once. In consequence of these shocks, also, whole islands are frequently sunk and new ones raised; the course of rivers is changed, and seas overflow the land, forming gulfs, bays, and straits. Sometimes the land is broken into islands, and sometimes islands are joined to the continent.

There are no portions of the earth's surface, whether it be land or water, that are not more or less subject to earthquakes; and records of their destructive effects have been transmitted to us through every age. The first earthquake particularly worthy of notice was that which, in A.D. 63, destroyed Herculaneum and Pompeii. In the fourth and fifth centuries, some of the most civilised parts of the world were almost desolated by these awful visitations. Thrace, Syria, and Asia Minor, according to contemporary historians, suffered most severely. On January 26, A.D. 447, subterranean thunders were heard from the Black Sea to the Red Sea, and the earth was convulsed, with little intermission, for the space of six months; and in Phrygia, many cities and large tracts of ground were swallowed up. On May 30, A.D. 205, the city of Antioch was overwhelmed by a dreadful earthquake, and 250,000 of its inhabitants are said to have been crushed in its ruins.

In the year 1346, Asia Minor and Egypt were violently shaken; and in the following year severe earthquakes were experienced in Cyprus, Greece, and Italy.

In 1692, the island of Jamaica was visited by a terrible earthquake, in which enormous masses of earth were detached from the Blue Mountains; and vast quantities of timber, hurled from their flanks, covered the adjacent sea, like floating islands. It was during this earthquake that the city of Port Royal, with a large tract of adjacent land, sank instantaneously into the sea. In the following year great earthquakes occurred in Sicily, which destroyed Catania and 140 other towns and villages, with 100,000 of their inhabitants.

Since the records of history, there have been no earthquakes equal in intensity to those which ravaged different parts of the world in the eighteenth century. Passing over the convulsion which in 1746 nearly laid waste Lower Peru, and those by which in 1750 the ancient town of Concepcion in Chili was totally destroyed, we come to 1755, when the city of Lisbon was almost wholly destroyed by one of the most destructive earthquakes which ever occurred in Europe. It continued only six minutes; but such was the violence of the convulsion that in that short space upwards of 60,000 persons are said to have perished. The pheno-

mena that accompanied it were no less striking. The sea first retired and laid the bar dry; it then rolled in, rising fifty feet or more above its ordinary level. The largest mountains in Portugal were shaken from their foundations; and some of them opened at their summits, which were split and rent in a wonderful manner, huge masses of them being thrown down into the subjacent valleys. But the most remarkable circumstance which occurred at Lisbon during this catastrophe was the entire subsidence of the New Quay, called Cays de Prada, to which an immense concourse of people had fled for safety from the falling ruins. From this hideous abyss, into which the quay sank, not one of the dead bodies ever floated to the surface; and on the spot there is now water to the depth of 100 fathoms. This earthquake excited great attention, from the extent at which contemporary shocks were experienced. The violence of the shocks, which were accompanied by a terrific subterranean noise like the loudest thunder, was chiefly felt in Portugal, Spain, and Northern Africa; but the effects of the earthquake were perceived in almost all the countries of continental Europe, and were even experienced in the West Indies, and on the Lake Ontario in North America. During the next twenty years, various earthquakes occurred in different parts of the world, attended with more or less destructive consequences. In 1759, Syria was agitated by violent earthquakes, the shocks of which were protracted for three months, throughout a space of 10,000 square leagues, and levelled to the ground Accon, Saphat, Balbeck, Damascus, Sidon, Tripoli, and many other places. In each of these places many thousands of the inhabitants perished; and in the valley of Balbeck alone, 20,000 persons are said to have been victims to the convulsion. In 1766, the island of Trinidad and great part of Columbia were violently agitated by earthquakes. In 1772, the lofty volcano of Papandayang, the highest mountain in Java, disappeared, and a circumjacent area, fifteen miles by six, was swallowed up. In 1783, the north-eastern part of Sicily and the southern portion of Calabria were convulsed by violent and oft-repeated shocks, which overthrew the town of Messina, and killed thousands of its inhabitants. In the same year the islands of Japan, Java in 1786, Sicily and the Caraccas in 1790, Quebec in 1791, and the Antilles and Peru in 1797, were violently agitated by convulsions of this kind.

Since the commencement of the present century, various earthquakes have occurred both in the Old and New World. In 1811, violent earthquakes shook the valley of the Mississippi, by which lakes of considerable extent disappeared, and new ones were formed. In 1812, Caraccas was destroyed, and upwards of 12,000 of its inhabitants buried in the ruins. In 1815 the town of Tombora, in the island of Sumbawa, was completely destroyed by an earthquake, which extended throughout an area 100 miles in diameter, and destroyed 12,000 persons. In 1819, a violent earthquake occurred at Cutch, in the delta of the Indus, by which, among other disastrous consequences, the principal town, Bhoog, was converted into a heap of ruins. In 1822, Aleppo was destroyed by an earthquake. In the same year Chili was visited by a most destructive earthquake, from which the coast for 100 miles is stated to have been raised from two to four feet, while about a mile inland from Valparaiso it was raised from six to seven feet. In 1827, Popayan and Bogota suffered severely from earthquakes, during which vast fissures opened in the elevated plains around the latter city. In 1835, the town of Concepcion, in Chili, was entirely demolished by an earthquake. In 1837, the countries along the eastern extremity of the Mediterranean, especially Syria, were violently agitated by an earthquake, which caused great damage to the towns of Damascus, Acre, Tyre, and Sidon, and entirely destroyed Tiberias and Safet. Such are some of the most violent earthquakes that have occurred within the period of authentic history. The reader will find in the reports of the meetings of the British Association lists of the different earthquakes that have taken place down to the year 1850; and from these it will be observed that scarcely a month elapses without being signalised by one or many convulsions in some part of the globe. Shocks of earthquakes have at different times been felt in various parts of the British islands; but they have been insignificant compared to those which have been experienced in other countries.

But though history supplies us with so large a catalogue of well-authenticated earthquakes, it is surprising that so little was done by the ancients either in investigating their causes or noticing their effects. It is only within the last century and a half, since Hooke first promulgated his views respecting the connection between geological phenomena and earthquakes, that the permanent changes effected by these convulsions have excited attention. Before that time the narrative of the historian was almost exclusively confined to the number of human beings who perished, the number of cities laid in ruins, the value of property destroyed, or certain atmospheric appearances which dazzled or terrified the observers. The creation of a new lake, the engulfing of a city, or the raising of a new island, are sometimes, it is true, adverted to, as being too obvious or of too much geographical interest to be passed over in silence. But no researches were made expressly with the view of ascertaining the amount of depression or elevation of the ground, or any particular alterations in the relative position of sea and land; and very little distinction was made between the raising of soil by volcanic ejections, and the upheaving of it by forces acting below. The same remark applies to a very large proportion of modern accounts; and how much reason we have to regret this deficiency of information appears from this, that in every instance where a spirit of scientific enquiry has animated the eye-witnesses of these events, facts calculated to throw light on former modifications of the earth's structure are recorded. There can be little doubt as to the unity of cause in volca-

noes and earthquakes. [VOLCANOES.] Earthquakes frequently precede violent volcanic eruptions, and often seem to arise from explosive matters accumulating their force from want of vent.

The agitation of the sea during earthquakes has often been remarked, and probably such effects are more common than is supposed, for irregularities in its motion have been at times observed, which cannot be referred to temporary currents or winds in the offing. The movement is generally a quick flow and reflow of the water, often so trifling as to escape the attention of all ordinary observers, though detected by seamen and fishermen, who are surprised to find boats suddenly floated, or as suddenly left dry.

During the Lisbon earthquake, many of the rivers and lakes of Great Britain were singularly disturbed. Loch Lomond suddenly rose between two and three feet, and as suddenly subsided.

In the great Calabrian earthquake, in 1783, the aspect of the country was singularly changed. The earth appears to have had an undulating, vibratory, and horizontal motion; there were the usual tremors in the neighbouring ocean; numerous deep and extensive gaps and fissures were formed, and faults and dislocations in the strata; large landslips took place, and extraordinary lacerations; large buildings and farms were engulfed; and in some places the chasms closed upon their prey with such violence that on excavating afterwards to recover articles of value, the workmen found detached parts of buildings jammed together in one compact mass. Some of the resulting gaps and ravines were upwards of a mile long, and from 200 to 300 feet deep and broad. Lakes were formed, sometimes filled with thermal waters from below, and sometimes the consequence of the obstruction of streams; land and houses were in some places uplifted, in others depressed, in others transferred with all their plantations to a distance varying from a few feet to upwards of a mile.

In the history of earthquakes it is a matter of much geological importance to establish clearly the fact of elevations and depressions of districts and strata; and, if possible, to ascertain the amount of such change. Upon these points the Chilian earthquake of 1822 affords some satisfactory evidence. The shock is said to have extended for more than a thousand miles along the coast, and a great part of the country was bodily elevated for a length of more than a hundred miles; the beach and the bottom near the shore being raised from three to four feet. The uplifting of the former was rendered evident by the adhesion of the shell-fish to the rocks; and it was observed that there were other lines of beach above that newly elevated, attaining in parallel lines a height of about fifty feet above the sea, seeming to show that previous elevations had been effected by the same causes. An old wreck of a ship, which before could not be approached, became accessible from the land; cones of earth were thrown up in several districts by the forcing up of water, mud, and sand, through funnel-shaped hollows. The elevation inland appeared, by the effect upon water-courses, to have been two or three times greater than upon the beach.

The parts of the earth subject to earthquakes are not only very widely extended and very numerous, but the total number of these disturbances recorded is enormous. The following tabular statement will illustrate this, the greatly increased number within the present century being rather an indication that more attention has lately been given to the subject than that the proportion is now larger than before:—

	Previous to Nineteenth Century	First Half of Nineteenth Century	Total
Scandinavian peninsula and Iceland	139	113	252
British Islands	124	110	234
Iberian peninsula	135	85	220
France, Belgium, and Holland	602	292	894
Basin of the Rhine and Switzerland	384	173	557
Basin of the Danube	173	145	318
Italian peninsula	884	478	1,362
Algeria and North Africa	—	—	63
Turco-Hellenic peninsula and Syria	373	197	570
Basin of the Atlantic	—	—	140
Canada and the United States	98	51	149
Mexico and Central America	37	30	67
The West Indian Islands	112	195	307
Chili and La Plata	24	170	194
	3,085	2,039	5,327

It is evident that very large districts of the earth are eminently subject to earthquakes. They occur also very frequently; for if the last fifty years have given such extraordinary results, compared with all previous time, it is so only because then, for the first time, the phenomena were specially recorded. It must also be remembered that earthquakes are only recorded in those limited districts of land peopled by races of men civilised and intelligent enough to be interested and not merely frightened by the convulsions of nature. We may conclude that more than sixty earthquakes take place on an average each year on the parts of the earth subject to observation, and of these about one in every eight months is on a large and important scale.

Since 1846 experiment has been brought to bear upon the enquiry, and in the hands of Mr. Mallet and others the young science of SEISMOLOGY (under which term we shall give a brief account of scientific investigation on the subject) has taken its place as a branch of cosmical physics. The earthquake of October 5 and 6, 1863, will long be remembered as one of the most severe ever felt in England, which is fortunately situated at a great distance from the regions frequently devastated by these startling phenomena. Other recent earthquakes occurred on the 9th of November, 1852,

when walls were thrown down at Shrewsbury, and on March 17, 1843, when buildings were damaged in the north of England.

Earwig. [DERMAPTERA; FORFICULA.]

Easel (Ger. esel, *an ass*). In Painting, a wooden frame used for supporting a picture during the progress of its execution.

Easement. In Law, a convenience which one man has of another, his neighbour, by grant or prescription. Easements were included in the Roman law under the title *servitutes*; such are a way over the lands of another, or a water-course.

East (Ger. ost). The point of the horizon at which the sun rises at the time of the equinoxes; or the point determined by a perpendicular to the meridian drawn towards the quarter of sunrise. The *east* is one of the four *cardinal points* of the compass.

East India Company. A famous joint-stock association originally established to carry on the trade between this country and the East Indies, or rather with the countries to the eastward of the Cape of Good Hope. It was constituted by royal charter in 1600, and continued, notwithstanding repeated efforts to open the trade, to enjoy the exclusive privileges originally conceded till 1688. At that period the power of the crown to restrain the freedom of trade without the sanction of parliament having been denied, a rival association obtained an Act of Parliament in its favour; but after a variety of negotiations, which it is unnecessary to specify, the two corporations were joined in 1702 under the name of 'The United Company of Merchants trading to the East Indies;' an appellation which has been continued to the present day. In 1708 the United Company was secured by parliament in the exclusive privilege of trading to all places eastward of the Cape of Good Hope to the straits of Magellan; and this privilege, with some modifications, was confirmed and prolonged by successive Acts of Parliament down to 1814. By the Act 53 Geo. III. c. 133, passed in 1813, the East India Company's charter was renewed for twenty years: but it then received some important modifications, by which a restricted intercourse with the whole of the company's Indian possessions was permitted to all British merchants; the monopoly of the trade between England and China being, however, retained in the hands of the East India Company. These concessions paved the way for the Act of 1833, by which, though the company's charter was prolonged till 1854, not only was the monopoly of the China trade abolished, but an end wholly put to the company's original character of a commercial association.

But it is not as a commercial association so much as a great territorial power, that the East India Company became distinguished. The first establishments of the English in India, as of other European nations, arose out of the alleged necessity of providing armed factories or strongholds, where the adventurers might warehouse their goods, and reside in safety for the purpose of carrying on their intercourse with the natives; but the factories speedily degenerated into fortifications, and the garrison into armies. For a while the power of the English and French was pretty nearly balanced in India; but the talents and victories of the famous Lord Clive gave us a decided superiority over every competitor, foreign or native, and extended our sway over some of the largest and finest portions of the Mogul empire. The policy of Clive, whether it was really approved by the succeeding governors-general of our Indian dominions, or forced upon them by necessity, has, some few short intervals excepted, been steadily followed up; and with such signal success, that our Indian empire, including protected states, comprises at present the whole of the peninsula from the Himalaya Mountains to Cape Comorin.

Under the Act 3 & 4 Wm. IV. c. 85, for continuing the charter till 1854, the functions of the East India Company were rendered wholly political. It was to continue to govern India, with the concurrence and under the supervision of the Board of Control [CONTROL, BOARD OF], nearly on the plan laid down in Mr. Pitt's Act, in 1784, by which the Board of Control was constituted. All the real and personal property belonging to the company on April 22, 1834, was vested in the crown, and to be held or managed by the company in trust for the same; subject, of course, to all claims, debts, contracts, &c. already in existence, or that may hereafter be brought into existence by competent authority. The company's debts and liabilities were all charged on India; the dividend, to continue at 10½ per cent., to be paid in England out of the revenues of India; and provision was made for the establishment of a *security fund* for its discharge. The dividend may be redeemed by parliament, on payment of 200*l.* for 100*l.* stock, any time after April, 1874.

The company's stock forms a capital of 6,000,000*l.*, into which all persons, natives or foreigners, males or females, bodies politic or corporate (the Governor and Company of the Bank of England only excepted), are at liberty to purchase, without limitation of amount. Since 1793, the dividends have been 10½ per cent., to which they are limited by the Act already cited.

The proprietors in general court assembled were empowered to enact by-laws, and in other respects were competent to the complete investigation, regulation, and control of every branch of the company's concerns; but, for the more prompt despatch of business, the executive detail was vested in a court of directors. A general court was required to be held once in the months of March, June, September, and December, in each year. No one could be present at a general court unless possessed of 500*l.* stock; nor vote upon the determination of any question unless in possession of 1,000*l.* stock for the preceding twelve months, unless such stock had been obtained by bequest or marriage. Persons

possessed of 1,000*l.* stock were empowered to give a single vote; 3,000*l.* made a qualification for two votes; 6,000*l.* for three votes; and 10,000*l.* and upwards for four votes. Upon any special occasion, nine proprietors, duly qualified by the possession of 1,000*l.* stock, might, by a requisition in writing to the court of directors, call a general court; which the directors were required to summon within ten days, or, in default, the proprietors might call such court by notice affixed upon the Royal Exchange. In all such courts the questions were decided by a majority of voices; in case of an equality, the determination to be by the treasurer drawing a lot. Nine proprietors might by a requisition in writing demand a ballot upon any question, which could not be taken within twenty-four hours after the breaking up of the general court.

The court of directors was composed of twenty-four members, chosen from among the proprietors, each of whom must be possessed of 2,000*l.* stock; nor could any director, after being chosen, act longer than while he continued to hold stock. Of these, six were chosen on the second Wednesday in April in each year, to serve for four years, in the room of six who had completed such service. After an interval of twelve months, those who had gone out by rotation were eligible to be re-elected for the ensuing four years. The directors chose annually from amongst themselves a chairman and a deputy-chairman. They were required by by-laws to meet once in every week at least; but they frequently met oftener, as occasion required. Not less than thirteen could form a court. Their determinations were guided by a majority. In case of an equality, the question must be decided by the drawing of a lot by the treasurer: upon all questions of importance, the sense of the court was taken by ballot. The company's officers, both at home and abroad, received their appointments immediately from the court, to whom they were responsible for the due and faithful discharge of the trust reposed in them.

The principal powers of the court of directors were vested in a secret committee, forming a sort of cabinet or privy council. All communications of a confidential or delicate nature between the Board of Control and the company were submitted, in the first instance at least, to the consideration of this committee; and the directions of the board, as to political affairs, might be transmitted direct to India, through the committee, without being seen by the other directors. The secret committee was appointed by the court of directors, and its members sworn to secrecy.

The territorial possessions of the East India Company were divided into the three presidencies of Bengal, Madras, and Bombay, at each of which the executive government was administered by a governor and three councillors, the governor of the Bengal presidency being at the same time governor-general of India. In their several presidencies, the governors and their councillors possessed the privilege of enacting and enforcing laws; subject, however, in some cases, to the concurrence of the supreme court of judicature, and, in all cases, to the approval of the court of directors and the Board of Control.

The following table (*Parliamentary Paper*, 1851), of which, however, it would be unsafe to guarantee the exactness, represented the area and population under the dominion of the company in 1851, not long before the period when it ceased to reign. Subsequently, however, it acquired the Punjaub, and considerable tracts of territory in Burmah and elsewhere :—

	Area	Population	Area	Population
BRITISH STATES.	sq. miles		sq. miles	
Bengal	325,652	47,958,320		
North-Western Provinces	85,571	23,800,549		
Madras	144,889	16,339,426		
Bombay	120,065	10,485,017		
Eastern Straits Settlements	1,575	202,540	677,752	96,785,852
NATIVE STATES.				
Bengal	583,404	43,054,596		
Madras	50,637	4,691,230		
Bombay	56,320	4,613,225	690,361	52,359,051
			1,368,113	151,144,903
FOREIGN STATES.				
French	188	171,217		
Portuguese	800	not known	988	171,217
Grand Total			1,369,101	151,316,120
INDIA BEYOND THE GANGES.—*British Acquisitions in* 1824 *and* 1825.				
Countries south of Rangoon, consisting of half the province of Martaban, and the provinces of Tavoy, Ye, Tenasserin, and the Mergui isles			12,000	51,000
The province of Arracan			11,000	100,000
Countries from which the Burmese have been expelled, consisting of Assam and the adjacent petty states, occupying a space of about			54,000	150,000
Total			77,000	301,000

Such was the height of power to which this celebrated body had attained, when the terrible outbreak of the Sepoy mutiny of 1857–8 occurred. It was repressed at a great expenditure of life and treasure, and mainly by the energy and political ability of the civil and military servants of the company itself. Nevertheless, this great event combined with many other causes to induce parliament and the public to believe that the time had arrived when the dominion of India ought to be transferred to the crown. The change was effected, after much discussion, by the Act 'for the Better Government of India,' 21 & 22 Vict. c. 106 (1858). The government of India, under the crown, was vested in a secretary of state and council, the latter consisting of fifteen members, partly nominated by the crown and partly elected by the whole body. The council now comprises several of those directors who took the most active part in the administration of the affairs of the company. The company itself is continued in existence by certain clauses of the Act, for the purpose of managing its funds, &c.; but its powers as a governing and as a commercial body have ceased altogether.

The subjoined return contains an account of the various stocks, loans, debts, &c. of the company, and subsequently of the crown government of India, including the 6,000,000*l.* of India stock already described:—

Return of all Stocks, Loans, Debts, and Liabilities chargeable on the East India Revenues, at Home and Abroad, up to the latest Period of Time to which such Return can be made out: viz. England, December 31, 1864; *India, April* 30, 1863.

INDIA: APRIL 30, 1863.—(The Rupee converted into Sterling at the exchange of 2*s.*)

	Registered Debt	Loans	Treasury Notes	Service Funds	Bills payable	Deposits and Miscellaneous	Total
	£	£	£	£	£	£	£
Government of India . .	62,234,484	2,798,882	1,288,196	2,879,843	1,897,251	5,366,916	76,465,572
Bengal . .	. .	. .	. .	. .	9,042	2,409,285	2,418,327
North-Western Provinces .	. .	. .	22,700	. .	. .	1,063,639	1,086,339
Punjaub . .	. .	63,500	. .	. .	. .	980,132	1,043,632
Madras . .	42,802	. .	295,860	891,449	177,231	902,411	2,309,753
Bombay . .	1,820	. .	7,950	1,808,998	214,351	1,661,167	3,694,336
Total . .	62,279,106	2,862,382	1,614,706	5,580,290	2,297,875	12,383,570	87,017,929

ENGLAND: DECEMBER 31, 1864.

East India Bonds	East India Debentures	India Five per Cent. Stock	India Four per Cent. Stock	Owing for Exports	Capital of Indian Railway and other Guaranteed Companies remaining in the Home Treasury, after deducting Sums (partly estimated) drawn by them in India	Bills of Exchange outstanding	Miscellaneous	Total
£	£	£	£	£	£	£	£	£
3,136,917	4,868,000	15,720,100	2,441,000	113,637	1,912,351	3,082	314,689	28,509,776

Easter (Ger. oster). The festival which is held in commemoration of our Lord's resurrection. The term, according to Bede, is derived from Eostra, which seems to be the same name as Ashtaroth.

The Jews celebrated their passover on the fourteenth day of the month Nisan, being the lunar month of which the fourteenth day either falls on, or next follows, the day of the vernal equinox. In the year of our Lord's crucifixion this fell on a Friday: the resurrection, therefore, took place on the first day of the next week, thence denominated the *Lord's day.* The primitive Christians in their desire to celebrate this anniversary rightly fell into two different systems. The Western churches observed the nearest Sunday to the full moon of Nisan, taking no account of the day on which the passover would be celebrated. The Orientals, on the other hand, following the Jewish calendar, adopted the fourteenth of Nisan upon which to commemorate the crucifixion, and observed the festival of Easter on the third day following, upon whatever day of the week that might fall; hence they obtained the name of Quartodecimantes: the former appealed to the authority of St. Peter and St. Paul, the latter to that of St. John.

The dispute upon this point in the second and third centuries is remarkable, as connected with perhaps the first event which can be brought to bear on the question of the primacy of the bishop of Rome; and it is the more interesting as both parties claim it as a testimony in favour of their own views. Victor, bishop of Rome, wrote an imperious letter to the Oriental bishops, requiring their conformity to the Western rule; which was answered by Polycrates, bishop of Ephesus, in the name of the rest, expressing their resolution to maintain the custom handed down to them by their ancestors. The Romish bishop thereupon broke off communion with them; but he was rebuked by Irenæus of Lyons, and it was agreed by his mediation that each party should retain its

own customs. Such continued to be the practice till the time of Constantine, when the council of Nice determined the matter by the following canons:—

1. Easter must be celebrated on a Sunday.

2. This Sunday must *follow* the fourteenth day of the paschal moon; so that if the fourteenth day of the paschal moon falls on a Sunday, then Easter must be celebrated on the Sunday following.

3. The paschal moon is that moon of which the fourteenth day either falls on, or next follows, the day of the vernal equinox.

4. The 21st day of March is to be accounted the day of the vernal equinox.

The new moons, it is necessary to observe, are those of the ecclesiastical calendar, which are determined arbitrarily (by the lunar cycle in the Julian calendar, and by means of the table of epacts in the Gregorian); so that the above rules define Easter without ambiguity. The new moons of the calendar are in general one or two days, sometimes even three days, *later* than the astronomical or true new moons; and the fourteenth day of the moon is accounted the full moon, although the opposition takes place more frequently on the sixteenth day. [CALENDAR; EPACT.]

Easy. The Sea phrase for a ship that moves over the sea without jerking or straining. In steamboats it is also the word of command to the engineer when a less degree of speed is required: in this sense it is also pronounced *ease her*.

Eau de Cologne (Fr.). A perfumed spirit originally prepared at Cologne, and principally used as a perfume; though many imaginary medical virtues have also been ascribed to it. Various recipes have been published for the preparation of eau de Cologne. The following affords a good imitation of the original article: Take of alcohol one pint; of the oils of bergamot, orange-peel, and rosemary, each one drachm; of bruised cardamom seeds, one drachm; orange-flower water, one pint; distil one pint from a water-bath.

Eau de Javelle. A bleaching and disinfecting solution of chloride or hypochlorite of soda.

Eau de Luce. A strong solution of ammonia, scented and rendered milky by the addition of a little mastic and oil of amber. It is considered an effective remedy in India against the bite of poisonous snakes.

Eau Médicinale (Fr.). Under this name a remedy for the gout was first brought into notice by Husson, a French officer. It attained great celebrity in this country about fifty years ago, and was much used till it was discovered that it was a vinous tincture of colchicum, since which it has fallen into disuse, and the officinal preparations of that drug have become its substitutes.

Eaves (A.-Sax. efese, *a margin* or *edge*). In Architecture, the lowest edges of the inclined sides of a roof which project beyond the face of the wall, so as to throw off the water therefrom. The eaves sometimes are provided with a semicircular cast-iron gutter and a down pipe, at other times they discharge the water upon the bare ground without the intervention of any gutter.

Ebbing of the Tide. The reflux of the tide. [TIDE.]

Ebenaceæ (Ebenus, one of the genera). A natural order of shrubby or arborescent Exogens of the Gentianal alliance, chiefly inhabiting the tropics. They are allied to *Oleaceæ*, with which they agree in the placentation of their seeds; but are distinguished by their alternate leaves and axillary flowers, which are usually unisexual. They are more closely related to *Aquifoliaceæ*, but differ in the number of their stamens and in their divided sexes. Some species are remarkable for the hardness and blackness of their wood, known under the name of Ebony and Iron-wood; others, as the *Kaki* of China, yield an eatable fruit. All are beautiful objects when growing.

Ebionites. An ancient sect (referred by Mosheim to the second century), who believed in Christ as an inspired messenger of God, but considered Him to be at the same time a mere man, born of Joseph and Mary. They maintained also the universal obligation of the Mosaic law, and rejected the authority of St. Paul. The origin of their name is uncertain, some deriving it from that of their supposed founder: others deduce it from a Hebrew word signifying *poor*, and suppose the title to be given to them in reference either to the *poverty* of the class to which they mostly belonged, or the *meanness* of their doctrine.

Eblanin. A yellow crystalline subtance, resulting from the action of potash on wood-spirit. [PYROXANTHINE.]

Ebonite. A hard black compound obtained by blending caoutchouc or gutta percha with variable proportions of sulphur.

Ebony. The heart-wood of various species of *Diospyros*. Mauritius Ebony comes from *D. Ebenum*; Coromandel Ebony is the wood of *D. Melanoxylon*; and the Bastard Ebony of Ceylon, that of *D. Ebenaster*. Ebony is heavier than water, takes a good polish, and gives off an aromatic odour when burnt.

Ebullioscope. An instrument for ascertaining the strength of spirit of wine, by the careful determination of its boiling point.

Ebullition (Lat. ebullio, *I bubble up*). The motion produced in a liquid by its rapid conversion into vapour.

Écarté (Fr. *discarded*). A game at cards for two persons, very popular in France. It is played with a piquet pack of 32 cards, all from the 6 to the 2 being excluded. The king ranks as the highest card; the ace ranks between the knave and 10; the other cards have the same relative value as at whist. Five cards are dealt to each player, and a trump card turned up. The non-dealer may then propose to throw out or *discard* any number of cards, which may be allowed or refused by the dealer, who in the former case gives an equal

number from the pack, and may change any number himself in like manner. If the elder hand is still dissatisfied with his cards, he may propose again and again till the pack is exhausted.

When the hands are settled, the two parties play alternately, the object being to win tricks, as at whist, and the play being regulated in the same manner, except that the second player must win the trick if he can, either by a higher card, or by trumping if he cannot follow suit. The game consists of five points, which are made as follows: The party who wins three tricks out of the five makes what is called the *point*, which scores one; winning all five tricks is called the *vole*, and counts two. A king turned up scores one for the dealer; and the king of trumps held in either hand scores one for the holder, but in this case it must be declared before playing. If the non-dealer decline to take cards, and lose the point, his opponent scores two for it instead of one; and if the dealer refuse to give cards on the first asking, and the opponent make the point, it scores two in like manner.

Ecbolics (Gr. ἐκβόλιον, a medicine which expels the fœtus). Remedies which by exciting uterine contractions promote the expulsion of the contents of the uterus. Savin and drastic purges have been termed *ecbolics*, but the only unequivocal agent of this class is *Ergot*.

Eccentric (Gr. ἐκ, and κέντρον, *a centre*). An arrangement of machinery by which a circular motion is converted into a horizontal or vertical one, or vice versâ. It usually consists of a circular disc placed upon the prime mover, which works in a frame, in connection with the piece to which motion has to be communicated, by means of a pulley, or collar moving freely upon the secondary motor. This kind of arrangement is generally adopted for communicating movement to the valves of steam engines, in which case the weight of the pulley is balanced on the shaft by a counter weight cast upon it.

Ecchymosis (Gr. ἐκχύμωσις). The extravasation of blood into the cellular membrane which results from blows and bruises.

Ecclesia (Gr. ἐκκλησία). In Ancient History, the great assembly of the Athenian people, at which every free citizen might attend and vote. This assembly, though nominally possessed of the supreme authority of the state from the earliest times, yet having no fixed times of meeting, was but seldom convened; so that the archons, who were elected from the body of nobles or eupatridæ, had virtually the whole management of the state. But the regulations of Solon, which appointed it to meet regularly four times in every period of thirty-five days, besides extraordinary occasions on which it might be convened, called it into active energy. Solon, however, restricted the subjects discussed in the Ecclesia to such as had before passed through the senate of five hundred; but when the democratic spirit of after-times prevailed, this rule was not strictly observed. The magistrates who had the management of these assemblies were the Prytanes [PRYTANES], the Prohedri [PROHEDRI], and Epistates [EPISTATES]. The first of these sometimes convened the people, and hung up in a conspicuous place a programme giving an account of the matters to be discussed. The *Prohedri* proposed to the people the subjects on which they were to decide, and counted the votes. The *Epistate*, who presided over the whole, gave the liberty of voting, which might not be done before his signal was given.

The forms of their proceedings were as follows: First, an expiatory victim was sacrificed, and his blood carried and sprinkled round the bounds of the assembly. Then the public crier demanded silence, and invited all persons above fifty years of age to speak; after that, anyone who pleased. After the subject was discussed, they proceeded to vote on the crier's demanding of them, 'whether they would consent to the decree proposed to them?' The votes were commonly given by show of hands, but on some occasions by ballot. When the suffrages had been examined and their numbers declared, the *Prytanes* dissolved the assembly. In order to incite the people to attend the Ecclesia, a small pay of one or three oboli was given for early appearance; and a rope, rubbed with vermilion, was carried through the Agora, to mark such as lagged behind, who were accordingly fined. From this, the most famous of Grecian public assemblies, the name passed to designate public assemblies regularly convoked in general: as in the Book of Acts the 'meeting' of the citizens of Ephesus is termed *ecclesia*, and those who search for the meaning of words in history can have no doubt that the word which we render *church* has in the same book the primary meaning of the regular 'meeting' or 'assembly' of Christians in any place.

Ecclesiastes (Gr.). A canonical book of the Old Testament: the word signifies 'the preacher,' and the book is popularly ascribed to Solomon.

Ecclesiastic. Something pertaining to or set apart for the church; in contradistinction to *civil* or *secular*, which regards the world. Ecclesiastics are persons whose functions consist in performing the service or in maintaining the discipline of the church. [CLERGY.]

Ecclesiastical Commissioners for England. Appointed originally in 1835 to consider the state of the dioceses of the church of England, and of the cathedral and collegiate churches, with reference to amount of revenues, &c. In pursuance of their Reports, the episcopal revenues were distributed on a new and permanent footing, approaching to equalisation: part of the revenues of collegiate and cathedral churches, with the whole endowment of non-residentiary prebends and offices, was carried to a fund in order to make better provision for the cure of souls. But large sums out of the fund thus created were in fact appropriated to the construction and repair of episcopal res-

dences. The commission was considerably enlarged in 1840 under the Act 3 & 4 Vict. c. 113.

Ecclesiastical Courts. The ordinary Ecclesiastical Courts in England and Wales are, beginning with the lowest:—

1. The Peculiar Courts, which are very numerous; Royal, Archiepiscopal, Episcopal, Decanal, Sub-decanal, Prebendal, Rectorial, and Vicarial; with jurisdiction frequently extending only to a single parish, and sometimes limited only to a part of the matters usually subject to ecclesiastical cognisance.

2. The Archdeacon's Court, generally subordinate, with an appeal to that of the bishop.

3. The Courts of Commissaries, especially appointed by the bishop.

4. The Diocesan Court of every bishop within his respective diocese.

5. The Provincial or Archiepiscopal Courts.

A suit is commenced in the Ecclesiastical Courts by a process, sued out by the party complaining, and served on the other party by an officer of the court. The party cited may appear either in person or by his proctor, who discharges duties similar to those of the attorneys in common law courts. A party disobeying citation may be pronounced contumacious, and imprisoned by an attachment out of the lord chancellor's court.

In case the party cited appear to show cause against his citation that the court has no jurisdiction, or that he is not amenable to it, this preliminary objection is heard upon petition and affidavits. If the judge decide against the defendant on the question of jurisdiction, the latter may apply to the courts of common law for a prohibition.

The law of the Ecclesiastical Courts is administered by men associated, as a distinct profession, for the practice of the civil and canon laws. They are incorporated as 'the college of doctors of law.' [DOCTORS' COMMONS.]

The jurisdiction of these courts may be considered as twofold: 1. In causes of a purely spiritual nature pertaining to the discipline of the church; 2. In causes of a civil nature, including some of a mixed character, partaking of the spiritual, such as suits for tithes in former times, suits respecting a right to seats in church, and the like.

1. The first of these branches arises out of the natural power exercised by every church to correct its communicants by censures and discipline submitted to. Under this class falls the cognisance of offences committed by the clergy themselves by neglect of duty, immoral or heretical delinquencies, suffering dilapidations, &c.; also by laymen, in brawling and other indecent conduct in churches and churchyards, in neglecting to repair churches, in cases of incest, incontinence, defamation. All these, except the last, are termed *causes of correction.* The punishments inflicted are monition, penance, excommunication, suspension *ab ingressu ecclesiæ*, and (in the case of clergymen) suspension from office and deprivation. In the case of laymen a great part of this jurisdiction has fallen into disuse; and the real penalty, whenever a cause is tried, consists, for the most part, in the payment of costs by the guilty party. The terrors so long attached to the process of excommunication (the only one by which ecclesiastical courts can enforce a sentence) are now matter of history. By the common law a person excommunicated was incapacitated from any legal act, and was, moreover, on certificate from the bishop, liable to imprisonment until reconciled to the church; but now, by the statute 53 Geo. III. c. cxxvii. the writ de contumace capiendo is substituted for the old writ de excommunicato capiendo in cases of contempt; and in the few cases in which excommunication is still pronounced as a sentence, the court is empowered to assign a term of imprisonment not exceeding six months. 2. In causes of a civil nature the functions of these courts may now be said to have very nearly ceased. These were divided into causes pecuniary, of which the greater part were extinguished by the abolition of tithes: matrimonial; abolished by 20 & 21 Vict. c. 85 [MARRIAGE] except in the matter of granting marriage licenses: testamentary; transferred in the same session, by the Act 20 & 21 Vict. c. 77, to a civil court, proceeding according to the course of the common law.

Ecclesiasticus. One of the apocryphal books of the Bible, composed, it is asserted, by Jesus the son of Sirach, and admitted by the Romish church into the canon of the Old Testament. This book was originally written in Syro-Chaldaic, and consists chiefly of meditations on religion and the conduct of human life.

Ecclesiology. A modern term denoting the science of church architecture, fittings, arrangements, and symbolism.

Eccoprotics (Gr. *ἐκ*, *out*, and *κόπρος*, *excrement*). The term formerly applied to mild aperient medicines.

Ecdysis (Gr. *ἔκδυσις*, *a stripping*). The moulting of the skin.

Échelon (Fr.). Signifies the position of a body of troops, when its divisions are so formed as to be behind one another in the form of steps. Formations in échelon are of two kinds—direct and oblique.

Echidna (Gr. *ἔχιδνα*, *an adder*). In Mythology, a monster, half-maid and half-serpent, of whom there are many legends, all varying greatly in detail. One myth, which connects her with Hercules and the Scythians, is given by Herodotus (iv. 8–10). For the meaning of the word, see Max Müller's *Lectures on the Science of Language*, first series, p. 366.

ECHIDNA. In Zoology, a name proposed by Cuvier for a genus of Australian quadrupeds, having the general form of an ant-eater, but covered with spines. The *Echidna*, like the *Ornithorhynchus*, deviates in a remarkable manner from the typical structure of the mammalia in general in the organisation of the generative and osseous systems, and forms with it a family or order called MONOTREMA

[see that word]. In the male of the *Echidna*, as in the *Ornithorhynchus*, the hind foot is armed with a curved spur, perforated like the fang of a viper by the duct of a poison gland, whence probably the reason for the name. Among the colonists of Australia, the *Echidna* is generally known by the name of the porcupine. It frequents sandy localities, lives in burrows, and feeds on ants and other insects, which it entraps by means of a long and adhesive tongue.

Echidnine. *Serpent Poison.* The secretion from the poison-glands of the viper and other serpents. It is a clear, viscid, neutral, yellowish fluid, containing albumen, mucus, fatty matter, and a yellow colouring principle; and among its salts, phosphates and chlorides. Associated with the albumen is a peculiar nitrogenous body to which the term *echidnine* has been more specially applied. The poison-bag of the viper seldom contains more than two grains of the poisonous liquid: 1-250th of a grain is sufficient to kill a small bird.

Echinate (Gr. ἐχῖνος, *a hedgehog*). In Botany, furnished with rigid hairs or prickles, as the husk of the Sweet Chestnut.

Echinococcus (Gr. ἐχῖνος, and κόκκος, *a cyst*). A genus of Hydatids or Cystic Entozoons, of which one species (*Echin. hominis*) is recorded by Rudolphi as infesting occasionally the human subject.

Echinodermata, Echinoderms, Echinoderma (Gr. ἐχῖνος, and δέρμα, *skin*). A name applied to a class of Invertebrate Radiate animals, which have a crustaceous or coriaceous integument, most commonly armed with tubercles or spines. They are classified as follows:

Order: *Crinoidea.*
  Families: Encrinidæ.
    Comatulidæ.
Order: *Asteroidea* (Starfishes).
  Families: Ophiuridæ.
    Stelleridæ.
Order: *Cystoidea.*
Order: *Echinoidea* (Urchins).
  Families: Clypeasteridæ.
    Echinidæ.
    Spatangidæ.
Order: *Holuthurioïdea* (Sea-cucumbers).
  Families: Holuthuridæ.
    Synaptidæ.
Order: *Sipunculoidea.*
  Families: Sipunculidæ.
    Echiuridæ.

Echinopora (Gr. ἐχῖνος, and πόρος, *a pore*). A subgenus of Madrepores [see that word].

Echinus (Gr. ἐχῖνος). The generic name of the Sea-urchins, which constitutes the type of the class *Echinoderma*. The Linnæan genus is now subdivided into many subgenera; some of which have their names compounded of Echinus and some other word, as *Echinobrissus, Echinocidaris, Echinoclypeus, Echinoconus, Echinocorys, Echinocyamus, Echinodiscus, Echinoampas, Echinometra, Echinoneus, Echinorodon,* &c.

Echinus. In Architecture, the name of the cushion or capital of the Doric order, from the circumstance that originally this member was painted with the echinus, the ornament commonly known as the *egg and tongue.* The painted ornaments have perished; but the Doric pillars of later times, executed after the custom was established of cutting or carving the ornamental details, have this decoration perfectly preserved. It is also one of the most characteristic running ornaments of the earlier period of Greek art, and abounds in the decorations of the Erectheium.

Echo (Gr. ἠχώ, *sound*). A sound reflected from a distant surface, and repeated to the ear. Though echo is a simple consequence of the reflection of sound, several conditions must be fulfilled before it can be produced. In the first place it is necessary that the ear be situated in the line of the reflection; and in order that the person who emits the sound may himself hear the echo, this line must be perpendicular to the reflecting surface, at least if there is only one reflecting surface; but if there are several such surfaces properly disposed, the sound may be brought back by a series of successive reflections to the point from which it emanated. In the second place, it is necessary that the opposing surface be at a certain distance from the ear; for if the direct and reflected sounds succeed each other with great rapidity, they are in some measure confounded, and the echo cannot be distinguished. Hence large rooms and vaulted caves have a strong *resonance,* but no echo is produced by them, the proximity of the walls rendering it impossible to distinguish the reflected sounds.

Observation proves that sound passes through the atmosphere at the rate of about 1,125 feet in a second; hence a person placed at half that distance, or 512 feet from the reflecting surface, would hear the echo exactly one second after the sound was emitted by him, and the echo would repeat as many distinct sounds as the ear can distinguish in a second. The utmost number of sounds which any ear can distinguish in a second perhaps does not exceed ten; hence the least distance of the reflecting surface from the point whence the sound is emitted must be about fifty feet, in order that an echo may be produced.

Everything which is capable of reflecting sonorous pulses may cause an echo; whence the wall of a house, or the rampart of a city, a wood, rocks, or mountains, produce echoes. Unless, however, the surface which reflects the sound is of considerable extent, the echo will be too feeble to be heard. A certain degree of concavity in the surface, by which several diverging rays of sound are collected and concentrated at the point where the echo is audible, is at least highly favourable, if not absolutely essential, to the production of echoes. It is a property of the ellipse that every sound proceeding from one of its foci, and impinging against the curve, is reflected into

the other focus; whence two persons placed in the two foci of an elliptic chamber may converse with each other in a whisper, and their voices not be heard by those who are in the other parts of the room. Hence also walls or buildings approaching to the elliptic form return sounds with great distinction and force. In the whispering gallery of St. Paul's, the faintest sound is conveyed from one side of the dome to the other, but is not heard at any intermediate point. In Gloucester cathedral a gallery of an octagonal form conveys a whisper seventy-five feet across the choir at its eastern end. Some echoes are remarkable for their frequency of repetition. An echo in Woodstock Park repeats seventeen syllables by day and twenty by night. Southwell (*Phil. Trans.* 1766) describes an echo in the Simonetta palace, near Milan, which repeated the report of a pistol sixty times. In Birch's *History of the Royal Society*, an account is given of an echo at Rosneath, near Glasgow, that repeats a tune played with a trumpet three times, completely and distinctly.

Echo. In Architecture, a term often applied, though incorrectly, to certain vaults, or arches, usually of an elliptical or a parabolical form, made for the purpose of producing artificial echoes.

Echometer. In Music, a sort of scale or rule, marked with lines which serve to measure the duration of sounds, and to ascertain their intervals and ratios.

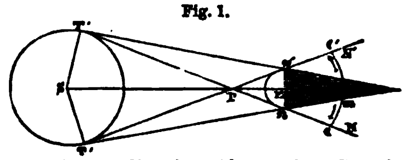
Eclectics (Gr. ἐκλεκτικός). Those philosophers who endeavour to select from the systems of various schools those doctrines alone which are true, and to present these in the form of an entire whole. An eclectic spirit, it is evident, can only arrive at a period of some maturity in philosophical speculation. Whether or not it is to be regarded as an evidence of the decay of original power in the age in which it appears, must depend on the less or greater coherence in the system when completed. In one sense of the word, Plato and Aristotle may be regarded as eclectics. They both availed themselves largely of the labours of their predecessors. Plato, in particular, comprehended in his scheme of philosophy the whole of more than one foregoing system; as the doctrine of Heraclitus of the perpetual flux of sensible objects and the consequent uncertainty of sensible impressions. But in the hands of these great thinkers the *discerpta membra* are reunited, and endued with a principle of vitality as constituent parts of a harmonious whole. The same cannot be said of others who have adopted a similar method; especially of most of those to whom the term *eclectic* has been more peculiarly applied. These philosophers lived chiefly under the Roman empire. The most celebrated among them may be said to have been Epictetus (A.D. 90) and Plutarch. The latter, in particular, a man of great and various endowments, may yet be taken as a striking instance of a false eclecticism. His great object, in his philosophical writings, seems to have been to reconcile the profound speculations and pure morality of the philosophers with the fanciful inventions and the gross theology of the poets and priests of Greece, Italy, or Egypt.

A far more favourable specimen of the eclectic spirit has been afforded us in modern times in the person of M. Victor Cousin, perhaps the most able and ingenious thinker of modern France. See his *Lectures on the History of Philosophy*.

Eclipses (Gr. ἔκλειψις, from ἐκλείπω, *I faint away or disappear*). Taken in a general sense, eclipses are phenomena produced by the obscuration of celestial bodies. They may be divided into two kinds, according to the circumstances under which they occur; viz. 1. When the obscuration is caused by an interception of the light received by the body from the sun; as in the cases of eclipses of the moon, eclipses of Jupiter's satellites, &c. 2. When the obscuration is caused by an interception, either totally or partially, of the light transmitted from the luminary to the spectator; this latter class embraces eclipses of the sun, occultations of stars and planets by the moon, the transits of Mercury and Venus over the disc of the sun, and of the satellites of Jupiter and Saturn over the discs of those planets. The eclipses of Jupiter's satellites, which can be calculated long beforehand, afford an extremely convenient method of determining longitude.

The most popular and generally interesting objects are the eclipses of the sun and moon. The earth and moon cast their shadows in directions opposite to the sun. As the figures of the bodies are nearly spherical, and as the sun is larger than either, it is plain that these shadows must be very nearly of a conical form. The moon is eclipsed when it becomes involved in the shadow of the earth, and so deprived of the light which it otherwise would receive from the sun. This can take place only at the time of full moon, or when the moon is in opposition to the sun. Let S represent the sun, E the earth, and $n't n$ its conical shadow, into which the rays of the sun do not enter. This shadow must evidently be a portion of the larger cone T t T′ which envelopes both bodies. Suppose the plane of the paper to be the plane of the ecliptic, or the plane in which the earth moves round the sun, and let ☾ ☾′ represent a portion of the path of the moon round the earth, the arrows

Fig. 1.

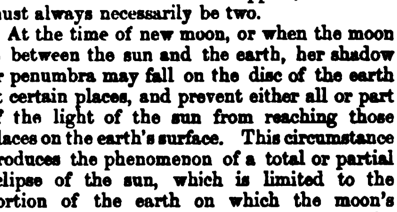


indicating the direction of her motion. Conceive also by means of cross tangents T P ☾, T′ P ☾′ the two opposite and circumscribing cones T P T′, ☾′ P ☾ to be drawn. The latter of these cones, ☾′ P ☾, is called the *penumbral cone*; and the space N n n' N′, projected beyond the earth, the *earth's penumbra*. It is evident that any

position within this penumbra is at least partially deprived of the light of the sun; for if we imagine a spectator to be in that position, it is obvious that the interposition of the earth would act as a partial screen and obscure a portion of the sun's disc from his view. It is also evident that a greater portion of the disc of the sun would be hidden from this supposed spectator as his position approaches nearer to the earth's shadow or *umbra*; and that if we suppose him to enter the shadow, he will become totally deprived of the light of the sun, the disc in this case being entirely hidden by the intervention of the earth. From this observation it follows that as the moon advances in the penumbra from ☾ to *m* her disc will receive less and less light from the sun, and its brightness will gradually diminish; also, as soon as a portion of the moon's disc enters the shadow, that portion becomes totally deprived of the light of the sun, and is, in other words, darkened or eclipsed. If in the course of the eclipse only a part of the moon's disc enters the earth's shadow, it is called a *partial eclipse*; but if the moon is totally darkened by the whole disc entering the shadow, it is called a *total eclipse*. It is to be understood in the diagram that the orbit of the moon, or the path which she describes round the earth, is not in the plane of the ecliptic or the plane of the paper, but inclined to it at an angle always greater than 4° 57′ and less than 5° 21′. This is the reason why eclipses of the moon do not happen at every full moon, for they can only take place when the moon's elevation above the ecliptic at full moon happens to be less than the semidiameter of the section of the earth's shadow through which she passes. In the course of a year there may be three eclipses of the moon, which is the greatest number that can happen; but there must always necessarily be two.

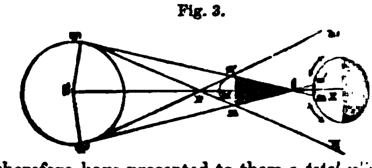
At the time of new moon, or when the moon is between the sun and the earth, her shadow or penumbra may fall on the disc of the earth at certain places, and prevent either all or part of the light of the sun from reaching those places on the earth's surface. This circumstance produces the phenomenon of a total or partial eclipse of the sun, which is limited to the portion of the earth on which the moon's shadow or penumbra happens to fall. The shadow of the moon does not always reach so far as the earth. In the two following diagrams, annexed by way of illustration, the former

Fig. 2.



represents the case in which it does reach, and the latter represents the case in which it does not reach, the surface of the earth. The shadow of the moon in the first diagram falls upon a portion of the earth's surface between *m* and *m′*; and the inhabitants, if any, of that portion, will evidently, from what has been said before, have the sun's disc wholly covered by the intervention of the dark body of the moon, and

Fig. 3.



therefore have presented to them a *total eclipse of the sun*. But in the second diagram, where the shadow of the moon does not reach the earth, if we suppose the dark conical shadow *n t n′* to be produced into the small opposite cone *m t m′* meeting the surface of the earth, it will be obvious, after a slight consideration, that any supposed spectator within this latter cone, or any inhabitant of the portion *m m′* of the earth, will perceive the dark body of the moon wholly within the disc of the sun, and intercepting only an interior part of his light; the unobscured part of the sun which circumscribes the disc of the moon will consequently present the appearance of a beautiful luminous ring or annulus, and the eclipse exhibiting this aspect is commonly called an *annular eclipse* of the sun; the cone *m t m′* may be similarly called the *annular cone*. It does not always occur, during the progress of an eclipse of the sun, that either the dark shadow of the moon or the annular cone will fall on the earth's surface, and it very rarely happens that either of them will fall on any defined spot, such as London or Edinburgh. For the occurrence of an eclipse on the earth, it is only necessary that the moon's penumbra N *n n′* N′ shall be projected against a portion of the terrestrial surface, as an inhabitant of that portion will at least have a part of the disc of the sun intercepted by the moon. When neither the moon's shadow nor the annular cone meets the earth in the course of an eclipse, and consequently only a part of the sun's disc is obscured to terrestrial vision, it is called a *partial eclipse of the sun*, and in that respect it is similar to a partial eclipse of the moon. If in the two diagrams we suppose, as before, the plane of the paper to be the plane of the ecliptic, the position of the moon must not necessarily be considered to be in that plane. The north pole of the earth will be directed upwards at an angle of about 23° 28′, and the arrows will represent the direction in which the earth revolves about its axis; the moon proceeds round the earth in the same direction, and carries her penumbra across the earth's surface with a much greater velocity than the earth's rotation. It follows, therefore, that the arrows indicate also the direction in which the phenomena of the eclipse pass geographically over the earth, viz. from west to east; and that different places will have the eclipse at a later or earlier time, according as they are more to

the east or west. Eclipses of the sun occur more frequently than eclipses of the moon. In the course of each year there must be two at least in some parts of the earth; but there cannot possibly be more than four. See also SUN for some phenomena attending solar eclipses.

Ecliptic (Gr. *ἐκλειπτικός*). In Astronomy, the great circle of the heavens which the sun appears to describe in his annual revolution. It has been called the *ecliptic* because eclipses happen only when the moon is in the same plane, or very near it. The ecliptic, from time immemorial, has been conceived to be divided into twelve equal parts, called *signs*—Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricornus, Aquarius, Pisces. But the signs of the ecliptic, or as they are sometimes called the *signs of the zodiac*, must not be confounded with the constellations, which have the same name and never alter their position in the heavens. The *signs* of the ecliptic denote merely arcs of 30°; and as they are reckoned from the intersection of the equator and ecliptic, which is not a fixed point, they are carried backwards by the precession of the equinox through the constellation. Thus the *sign* Aries is now in the *constellation* Pisces.

The ecliptic is the circle to which longitudes and latitudes in the heavens are referred, as right ascensions and declinations are referred to the earth's equator.

The angle which the plane of the ecliptic makes with the plane of the equator is called the *obliquity of the ecliptic*. [EARTH.] The obliquity of the ecliptic on June 1, 1865, was 23° 27′ 15·87″. It is liable to variation from the earth's NUTATION [which see] and other causes.

Ecliptic Digits. [DIGITS.]

Ecliptic Limits. The greatest distances at which the moon can be from her nodes, in order that an eclipse of the sun or moon may happen. When the moon is within those limits at the time of the new or full moon, an eclipse certainly happens; but when the moon is beyond those limits, an eclipse cannot happen. The limits for an eclipse of the sun are about 17°, and for an eclipse of the moon about 12°.

Eclogue (Gr. *ἐκλογή, a selection*). In the original meaning of the word, the select or choice pieces of an author; or extracts collected out of former works, such as were termed in Latin *excerpta*. It is not known how this title was originally given to the pastoral poems of Virgil; but from the circumstance of their being so named, the word *eclogue* in modern usage is applied to that species of poetry. The persons who are introduced conversing in eclogues, or whose adventures are recounted in them, are shepherds; that is, for the most part, imaginary personages, whose sentiments, and the external circumstances among which they live, belong rather to an ideal age of gold than to the realities of modern life; and their loves constitute the main and proper subjects of the eclogue. Nevertheless, various writers (Gay, &c. among ourselves) have endeavoured, but with little success, to give an air of greater reality to pastoral poetry, and give their rustics more of the costume and diction of actual clowns; but the result has been a species of burlesque, not at all answering to our conceptions of pastoral poetry; nor can we easily imagine that the personages of Theocritus, although the earliest and therefore the simplest of pastoral poets, are correct resemblances of the Sicilian rustics among whom the writer lived. Some only of the eclogues of Virgil have the true character of pastorals; others are occasional poems on public and private events of the day, very slightly enveloped in the pastoral costume. The characteristics of this species of poetry, as assumed by the moderns, are: first, the representations of pastoral landscape; secondly, a slightly dramatic turn either of action or narration; thirdly, characters whose sentiments and language are confined within certain peculiar limits: thus, any strong emotion, virtue, or vice, would be an unfit topic for a pastoral poet to dwell upon. Among ourselves, Spenser, Philips, and a few others, may be named as pastoral poets in the strict sense of the word; others, as Milton in his *Lycidas*, have assumed the pastoral costume in order to convey a very different class of ideas. It is worthy of remark, that this species of composition is among those which have wholly disappeared in the present day: we have had no pastoral poet since Gay and Collins; and Gesner, in Germany, is the latest author who has acquired any degree of celebrity in this line, unless the poems of Voss, and Goethe's beautiful *Herman and Dorothea*, be placed, as they sometimes are, in this class of poems. [IDYLL; BUCOLIC.]

Economic Geology. The application of geology to practical and economic purposes. This branch of the science is sometimes called *Practical Geology*, and it has arisen to great importance since the knowledge of geology has become definite, and the speculative has been removed from the descriptive branch of the science.

The applications of geology are many and varied. Each of them will be found treated of under special headings. To the agriculturist, the engineer, the architect, and, above all, to the miner, an acquaintance with certain departments of geology is now indispensable.

The facts of geology that chiefly bear on practical applications are these: 1. The nature and ordinary properties of the principal rocks; their various states, mechanical and chemical, and the modification they usually undergo, or are capable of undergoing in nature. 2. The sequence of rocks, and the means that exist for identifying them. 3. The mechanical disturbance and displacement of rocks. 4. The formation and filling up of those crevices, fissures, and other open spaces that affect rocks, especially those that have undergone much change whether mechanical or chemical. These

facts concerning the original composition, the subsequent modification, and the present condition of rocks, are the basis of knowledge in economic geology. They will be found discussed at greater length in various articles. [DESCRIPTIVE GEOLOGY.]

The following are the principal subdivisions of economic geology: 1. AGRICULTURAL GEOLOGY; 2. ENGINEERING GEOLOGY; 3. ARCHITECTURAL GEOLOGY; 4. MINING. Under the heads BUILDING MATERIAL and CLAY will be found a notice of the economic geology of the varieties of clay and other plastic substances used for construction, whether on a small or large scale. QUARRYING and STREAM WORKS will also be separately noticed in reference to building stone, road metal, and certain deposits of metalliferous gravel that properly belong to Economic Geology. See also STONE.

Economy, Political. [POLITICAL ECONOMY.]

Ecostate (Lat. e, and costa, *a rib*). In Botany, applied to leaves which have no central rib or costa.

Ecthesis (Gr. ἔκθεσις). In Ecclesiastical History, the name given to a decree of the emperor Heraclius, issued A.D. 639, for the purpose of putting an end to the Monothelite controversy. It was probably drawn up by the patriarch Sergius, and declared the doctrine of Two Wills in Christ to be heretical. It was withdrawn by the emperor Constans, who in 648 issued his *Type*, a decree which sought to settle the question by imposing silence on both sides, and prohibiting the use of the terms, whether of the single or double will. The *Type* was condemned by Martin I. at Rome in the following year.

Ecthyma (Gr. ἔκθυμα, *a pustule*). A pustular skin eruption, occurring generally as the result of debility and long-continued ill-health. It may appear on the head, face, body, or extremities. When the pustules break, dark scabs remain; and these, when they fall off, leave red marks on the skin, which fade away very slowly. Ecthyma frequently occurs in old syphilitic cases. The treatment consists in the administration of tonics, especially the mineral acids and bark.

Ectropium (Gr. ἐκτρόπιον, from ἐκτρέπω, *I turn away*). An unnatural eversion of the eyelids, arising from tumefaction of the inner membrane, or from a contraction of the skin covering the eyelid.

Eczema (Gr. ἔκζεμα, from ἐκζέω, *I boil* or *break out*). A disease of the skin, known by an eruption of small vesicles, generally very close together; but little redness is at first produced, although irritation often ensues. The heat of a summer sun sometimes produces the eruption, which has then been called *eczema solare*. Under irritation, eczema may become partly pustular, while the irritating fluid discharged from the vesicles reddens and inflames the skin, producing great distress. Bakers, grocers, and other persons whose hands come in contact with irritant matters, sometimes suffer severely. One painful form of the disease is *eczema rubrum* or *mercuriale*, frequently seen in those who have used mercury freely, though it may also occur without any such especial cause. It affects every part of the body, and sometimes the entire skin becomes diseased. The treatment of eczema consists in improving the secretions, and supporting the system by good diet and tonics. The irritation of the skin is often greatly relieved by lukewarm baths and mild fomentations.

Edaphodonts (ἔδαφος, *a base*, and ὀδούς, *tooth*). A group of fossil fishes from the greensand chalk and tertiary strata, in which each upper maxillary has three dental columns; the premaxillary dental mass consisting of five vertical and slightly bent series of oblique and curved transverse plates; the median and largest series being strengthened by a supplementary dental column behind.

Edda (Norse). The ancient collection of Scandinavian poetry in which the national mythology is contained. There are two Eddas: the older is believed to have been reduced to writing, from oral tradition, in Iceland, between A.D. 1050 and 1133. It was recovered and published in Denmark in 1643. The new Edda, supposed to have been composed 200 years after the former, is an abridgement of it, with a new arrangement of its parts. It was translated by Resenius in 1640, and is thence called the Resenian Edda. The authenticity of these monuments of an early age has been doubted in recent times; but the latest researches of critics (the brothers Grimm and others) seem to go far towards establishing it.

Eddoes. The tuberous stems of various *Araceæ*, as *Colocasia esculenta*, *Caladium bicolor*, *violaceum*, &c., often eaten in tropical countries.

Eddy (commonly referred to A.-Sax. Edea, *breakwater*; but Mr. Wedgwood holds that it represents the old Norse *yda*, a whirlpool: *Dictionary of English Etymology*). The water of a stream or tide which, in consequence of striking against some obstacle, is thrown backwards, and runs in a direction opposite to that of the general current. More frequently, however, the term is used to denote the whirling or circular motion caused by the meeting of two opposite currents; and, in this sense, it is also applied to a similar motion of the atmosphere. [WHIRLPOOL; WHIRLWIND.]

Edentals, Edentata (from Lat. e, and dens, *tooth*). The name of an order of Mammals, including those genera in which the dental apparatus is more or less incomplete: the incisive teeth are almost always deficient. [BRUTA.]

Edge of Regression of a Surface. The curve generated by the successive intersections of the characteristics of a surface. The French equivalent, *arête de rebroussement*, appears to have been first used by Monge; in England, the synonymous term *cuspidal edge* is generally preferred. [CUSPIDAL EDGE and CHARACTERISTIC.]

Edict (Lat. edictum, from edico, *I speak out*). An instrument signed and sealed to serve as a law. In ancient Rome the name was given to the ordinances of the magistrates, but especially of the two prætors, *prætor urbanus* and *prætor peregrinus*, who on their accession to office published *edicts* or rules for regulating the practice of their courts, as well as for their own guidance in the decision of doubtful cases. A jurisdiction, however, thus vague and arbitrary in its nature, being constantly abused, it was enacted by the Cornelian Law (B.C. 56) that the prætor of the year should be compelled to adhere to the spirit and letter of his first proclamation. The edicts of the preceding prætor were not binding on his successor. If the latter confirmed them, they were styled *edicta vetera* or *tralatitia*; in contradistinction to *edicta nova*, those framed by himself. [PRÆTOR.] Under the emperor Hadrian, a digest of the best decisions of the prætors from the earliest times was made by Sylvius Julianus, collected into a volume called *Edictum Perpetuum*, or Perpetual Edict, ratified by the emperor and senate, and fixed as the invariable standard of civil jurisprudence. (Gibbon's *Roman Empire*, ch. xliv.)

The *Edict of Milan* was a proclamation issued by Constantine after the conquest of Italy (A.D. 313), to secure to the Christians the restitution of their civil and religious rights, of which they had long been deprived, and to establish throughout his extended dominions the principles of a wise and enlightened toleration.

The most famous edict of modern history is the Edict of Nantes, issued by Henry IV. in 1598, to secure to the Protestants the free exercise of their religion. This act, after continuing in force for nearly a century, was repealed by Louis XIV.; and, as is well known, its revocation led to a renewal of the persecutions and bloody scenes which before the issuing of this edict had been enacted against the Protestants. The depopulation caused by the sword was also increased by emigration. Above half a million of her most useful and industrious subjects deserted France, and exported, together with immense sums of money, those arts and manufactures which had chiefly tended to enrich the kingdom. About 50,000 refugees passed over into England; and there can be little doubt that their representations of the cruelties perpetrated by the king of France tended to excite the suspicion of the English against their own Roman Catholic sovereign, and in some degree accelerated the Revolution of 1688. [HUGUENOTS.]

In the French law, the term *edict* has a wide signification, being applied equally to the most momentous and the most trifling proclamations of the government.

Edingtonite. A mineral found in Dumbartonshire in small greyish-white translucent prisms, composed of silica, alumina, baryta, and water. Named after the discoverer, Mr. Edington.

Edition (Lat. editio, from edere, *to give out or publish*). This word denotes properly the (indefinite) number of copies of a work printed at one time, before the types are distributed by the compositor. Anyone who prepares for publication the writings of another is said to edit them, and is called the *editor*. In literary language, since the invention of printing, the *editor* of a work revises, adds notes, prepares for the press, &c. &c.; the *publisher* is the bookseller who negotiates the sale of the impression. Sometimes (but especially in classical works) the edition goes generally by the name of the printer or publisher, sometimes by that of the editor. Thus, we have the Aldine and Elzevir Classics, &c., the houses of Aldus and Elzevir having been concerned both in printing and publishing; while Bentley's *Horace*, Heyne's *Homer*, &c., are so denominated from the name of the *editor*. In Bibliographical works, *editio princeps* signifies the earliest printed edition of an author; *editio optima*, that which is generally regarded as the best, &c.

Edriophthalma (formed from Gr. ἑδραῖος, *fixed*, and ὀφθαλμός, *an eye*). The name under which the Malacostracous Crustaceans with sessile eyes are grouped together.

Education (Lat. educatio). In its most extended signification, may be defined, in reference to man, to be the art of developing and cultivating the various physical, intellectual, and moral faculties; and may thence be divided into three branches—physical, intellectual, and moral education. This definition is by no means complete; but it is used merely as indicative of the manner in which this subject has generally been discussed. Under physical education, is included all that relates to the organs of sensation, and the muscular and nervous system. Intellectual education comprehends the means by which the powers of the understanding are to be developed and improved, and a view of the various *branches of knowledge* which form the objects of instruction of the three departments into which we have divided education. Moral education embraces the various methods of cultivating and regulating the affections of the heart.

Eduction Pipes. The pipes in a steam engine through which the steam is led from the cylinder, after it has accomplished its work, through the escape valves to the condenser.

Edulcoration (Lat. edulco, *I purify* or *sweeten*). A chemical term applied to the cleansing of substances, especially pulverulent precipitates, by the repeated affusion of water, so as to remove all soluble matters, and render them free from taste and smell.

Eel (Ger. aal). There are three species of eels indigenous to the British Isles—the Sharpnosed (*Anguilla acutirostris*), the Bluntnosed (*A. latirostris*), and the Middlenosed (*A. mediorostris*). The Sharpnosed is the best and commonest variety; the Bluntnosed is a coarse and comparatively worthless fish, fierce, voracious, and filthy in its food, of an

offensive odour before it is cooked, and a repulsive flavour afterwards. The mode of procreation of eels has long been a doubtful question; but it seems now satisfactorily ascertained that they are produced after the manner of fish generally, namely from deposited ova, that they chiefly breed in brackish waters, and that the young fish (elvers) ascend from the estuaries in countless thousands, migrating from the sea, and overcoming extraordinary difficulties in their passage up rivers. Their migrations principally take place in spring and early summer; but of the myriads that ascend, comparatively few escape the enemies that beset them on their journey. In some salmon rivers, the pools are in a perfect boil with the rising of the salmon at the small eels; and cartloads of the fry are sometimes collected for sale in Cornwall and Devonshire, and made into cakes, or even used as manure, or given to the pigs. But although eels descend from rivers or lakes for the purpose of depositing their ova in salt or brackish water, there can be little doubt that they may also breed in waters having no communication with the sea. This seems to have been experimentally verified, though it has been suspected that in these cases the fish may have availed themselves of some overland communication with an adjacent river, making their way through moist meadows or shallow watercourses.

The high repute in which eels were held by the ancients is well known: they were deified by the Egyptians, and invoked by the ancient Greeks as 'the Helen of the dinner table,' because every guest strove like Paris to supplant his neighbour, and keep her for himself; and the Russians kept them in their fishponds ready at hand for the table. With us at the present day eels are duly appreciated; the London market is chiefly supplied from Holland, and it appears from an estimate made by Mr. Mayhew (*London Labour and London Poor*) that between nine and ten millions of eels are annually sold at Billingsgate, amounting in weight to more than 1,500,000 lbs., of which above one-fourth is sold by the costermongers chiefly for the sustenance of the working classes. The price of the eels required for the Billingsgate trade amounts to the annual sum of more than 12,000*l*. The Conger Eel (*Conger vulgaris*) differs little in structure, but attains enormous dimensions. Specimens weighing from 50 to 130 lbs., measuring more than ten feet long and eighteen inches in circumference, have occasionally been captured. The flesh of the conger is tough and disagreeable; yet it is not only sometimes eaten, especially in soup, but in the Isle of Man it may be said to take the place of the poor man's pig. It is caught there in abundance, and is split, salted, and dried. (See *Quarterly Review*, 1864, and the authorities there quoted.)

Eel, Electric. [Gymnotus.]

Effect (Lat. effectus). In the Fine Arts, that quality in works of art whose nature is to give particular efficacy to other qualities, so as to bring them out and to attract the eye of the spectator.

Effect. [Keeping.]

Effendi. A Turkish word signifying *lord* or *superior* (from the Greek αὐθέντης), applied to legal, ecclesiastical, or other *civil* functionaries, in contradistinction to *aga*, the name by which high *military* personages are designated. [Reis Effendi.]

Effervescence (Lat. effervesco). The escape of gaseous matter from liquids, as in the act of fermentation. All liquids from which bubbles of gas rapidly escape, so as to resemble boiling, are said to effervesce.

Effigy (Lat. effigies). In Painting and Sculpture, the representation of an individual.

Efflorescence (Lat. effloresco). The spontaneous crumbling down of transparent crystals in consequence of their loss of water.

Effluvium (Lat. *a flowing out*). The vapours arising from putrefying matters.

Effusion (Lat. effusio, *a pouring out*). In Surgery, the escape of a fluid from the vessel naturally containing it; thus when the chest is wounded, blood may be effused into the cavity of the pleura, and in injuries of the head blood may be effused upon the brain, when death almost inevitably ensues.

Egeran. A variety of Garnet found near Eger in Bohemia.

Egeria (Lat.). One of the small planets between Mars and Jupiter. It was discovered at Naples on Nov. 2, 1850, by Dr. de Gasparis (who had previously discovered Hygeia and Parthenope), and is the thirteenth of the group in the order of discovery. [Planet.]

Egg (A.-Sax. æg; Ger. ei). The ovum of birds and oviparous animals. The changes which the hen's egg undergoes during incubation have been described by Sir E. Home in the *Phil. Trans.* for the year 1822 (page 339), and illustrated by a beautiful series of plates after Bauer's drawings: the same volume also contains a valuable paper by Dr. Prout on the same subject, but chiefly in reference to the chemical changes of the egg during that process. The specific gravity of new-laid eggs at first rather exceeds that of water, varying from 1,080 to 1,090; but they soon become lighter, and swim on water, in consequence of evaporation through the pores of the shell. When an egg is boiled in water and suffered to cool in the air, it loses about 32 hundredths of a grain of saline matter, together with a trace of animal matter and free alkali. The mean weight of a hen's egg is about 875 grains, of which the shell and its inner membrane weigh 93·7 grains, the *albumen* or white 529·8 grs., and the yolk 251·8 grs. The shell contains about 2 per cent. of animal matter and 1 per cent. of the phosphates of lime and magnesia, the remainder being carbonate of lime with a trace of carbonate of magnesia. When the yolk of a hard-boiled egg is digested in repeated portions of strong alcohol, there remains a white residue having the leading characters of albumen, but containing pho-

phorus in some peculiar state of combination: the alcoholic solution is yellow, and deposits a crystalline fatty matter, and when distilled leaves a yellow oil. The albumen of the egg contains sulphur. The use of the phosphorus is to yield phosphoric acid to form the bones of the chick; but the source of the lime with which it is combined is not apparent, for it has not been detected in the soft parts of the egg, and hitherto no vascular communication has been discovered between the chick and the shell.

The trade in eggs is of great value and importance; the number of eggs imported into this country from various parts of the Continent greatly exceeds one hundred millions; and there is every prospect of a steady increase.

Egg-plant. The Aubergine *Solanum esculentum*, the fruits of which resemble hens' eggs.

Eglantine (Fr. églantier). The old English name of the *Rosa rubiginosa* or Sweet-brier Rose; also *Rosa Eglanteria*. The term is improperly applied by Milton to the honeysuckle.

Egyptian Architecture. [ARCHITECTURE.]

Egyptian Bean. The fruit of the *Nelumbium speciosum*, which has been regarded as the forbidden bean of the disciples of Pythagoras.

Egyptian Pebble. A species of Jasper found in roundish pieces, scattered over the surface of the Desert, between Cairo and the Red Sea.

Eider Duck. The species of duck tribe so called is one of the largest and most valuable of the *Anatidæ*, and, from certain modifications of the beak and sternum, constitutes the type of a subgenus, called *Somateria*. The common eider (*Somateria mollissima*) frequents in great numbers the Orkneys, Hebrides, and Shetland isles. It is defended from the cold of the dreary northern coasts by the developement of an unusual quantity of the finest down beneath the dense exterior plumage, which is equally well adapted to form an impenetrable barrier to the wet. The down of the eider constitutes its chief value, as it combines with its peculiar softness, fineness, and lightness so great a degree of elasticity that the quantity of this material which might be compressed and concealed between the two hands will serve to stuff a coverlet.

As the female plucks from her own body a quantity of her finest down to line her nest, the Orcadians avail themselves of this instinct, and take an early opportunity to rob the nest of both eggs and down. She then begins to lay afresh, and envelopes her eggs with another layer of down; and if this be removed, the male is said to contribute his own down when the female can afford no more. Lastly, when the brood of ducklings is hatched, the nest is again visited and the down removed. Thus a considerable quantity of the valuable material furnished by the eider-duck is obtained independently of that which is plucked from the slaughtered birds. Besides the down and eggs, the islanders turn the skins and flesh of the eiders to profit; while these birds cost them no expense, as they feed entirely on seaweed and other natural productions of the ocean.

Eidograph (Gr. εἶδος, *form*; γράφω, *I describe*). A copying instrument invented by Professor Wallace, of Edinburgh, by which copies of drawings are made, reduced, or enlarged in any proportion within certain limits. It answers the same purposes as the ordinary pentagraph, but is more convenient and accurate. The instrument was invented about 1821, and was first described in the *Transactions of the Royal Society of Edinburgh*, vol. xiii.; it is also described in Wallace's *Geometrical Theorems and Analytical Formulæ*, 1839.

Eikon Basilikê (Gr.). The title of a work, attributed to Charles I.; but the authorship of this 'Portraiture of his Sacred Majesty in his Solitude and Sufferings' has been traced to John Gauden, bishop of Exeter, on evidence which Sir James Mackintosh pronounced to be conclusive.

Eisteddfod (Welsh, from eistedd, *to sit*). The assemblies or sessions of the Welsh bards were so termed. [BARD.] They were held, according to Pennant (*Tour in Wales*), at different places for the minstrels of their respective neighbourhoods; at Caerwys, at Aberfraw in Anglesea, and Mathravel in Powys. The judges were appointed by commissions from the Welsh princes, and after the Conquest from the English kings. The last was issued in 1568. But the Gwynnedigion and Cambrian Societies have lately revived the old custom; and annual meetings for the recitation of prize poems, and for performances on the harp, are now held under the name of Eisteddfod.

Ejectment (Lat. ejectio, *a casting forth*). In Law, is a personal action in the form of trespass, in which a tenant for years claims damages for his expulsion from land demised to him; and it became the usual form of trying questions of right to real property by a singular fiction—the party claiming land or its appurtenances not in his possession through the means of a fictitious tenant (the celebrated John Doe). This fictitious mode of proceeding was, however, abolished by the Common Law Procedure Act 1852 (15 and 16 Vict. c. 76), and a series of simple rules substituted for it. The effect of judgment for the plaintiff in ejectment is that he recovers the possession only of the land claimed, with or without costs, but not any particular estate or interest therein. As a general rule, therefore, a judgment in ejectment does not conclude the title, and an unsuccessful claimant can bring another action of ejectment.

El Dorado (Span. *the golden region*). The name given by the Spaniards in the sixteenth century to a country supposed to be situated in the interior of South America, between the rivers Orinoco and Amazon. After the Spanish conquest of Mexico and Peru, the most exaggerated accounts of the wealth and riches of the newly acquired territory were circulated and believed. A new region was fabled to exist far surpassing the wealth and splendour of Peru;

expeditions were fitted out for the purpose of discovering it; and though all such attempts proved abortive, the rumours of its existence continued to be believed down to the beginning of the last century. The term has now passed into the language of poetry, in which it is used to express a land of boundless wealth, like the ancient Elysium or the Mohammedan Paradise.

Elæagnaceæ (Elæagnus, one of the genera). A natural order of shrubby arborescent Exogens inhabiting the entire northern hemisphere down to the equator, having leprous leaves, superior fruit, and apetalous flowers with a tubular calyx. They are distinguished from *Thymelaceæ* by the ovule being erect; from *Proteaceæ* by the valvate calyx, and the dehiscent fruit of the latter; and from *Santalaceæ* by the superior ovary. The berries of some species are eaten in Persia and Nepal.

Elæis (Gr. ἐλαία, *an olive-tree*). The Oil Palm of Africa, *E. guineensis*, yields the celebrated palm oil so much used in this country in the manufacture of candles. This tree is a native of west tropical Africa, where it occurs in great numbers, yielding an enormous quantity of fruits, from the outer fleshy coating of which the oil is obtained by boiling in water and skimming off the oil as it rises to the surface. Its production and preparation are carried on solely by the negro population. The amount of palm oil imported to this country, in 1863, was nearly 800,000 cwt.

Elæolite (ἔλαιον, *oil*, and λίθος, *stone*). A name given to the coarse massive kinds of Nepheline which have a waxy or greasy lustre. It is of various shades of green, grey and red, and is a silicate of alumina, potash, and soda. It is found in zircon-syenite at several places in Norway; in the Ilmen mountains, and in North America. The pale-blue varieties are slightly opalescent, and are sometimes used for ring-stones.

Elæometer (Gr. ἔλαιον, and μέτρον, *measure*). An instrument for detecting the adulteration of olive oil.

Elæoptene (Gr. ἔλαιον, and πτηνός, *winged*). The *liquid* portion of the volatile oils, when separated from the concrete, or crystallisable portion, which has been called *stearoptene*.

Elaidin (Gr. ἔλαιον). A fatty matter produced by the action of nitric acid upon certain oils, especially upon olive oil and almond oil.

Elain (Gr. ἔλαιον). That portion of fat or oil which retains a liquid state at ordinary temperatures; it may be pressed out of hog's lard and other solid fats, and separated from oils by exposing them to cold and subsequent pressure. [OLEIN.]

Elaphrium (Gr. ἐλαφρός, *light*). A genus of *Amyridaceæ* yielding some of the medicinal resins. Mexican Elemi is said to be furnished by *E. elemiferum*.

Elaps. A subgenus of viper. [VIPERA.]

Elasmotherium (Gr. ἐλασμός, *a metal plate*, and θήρ, *a beast*). The name of an extinct Pachydermatous animal, which forms the type of a new genus, characterised by the laminated structure of its teeth, and intermediate between the horse and rhinoceros.

Elastic Bitumen. A variety of Bitumen found in soft masses (which sometimes become harder on exposure), of various shades of brown. It is flexible and elastic (whence the names *Elaterite* and *Mineral Caoutchouc*). It is met with at the Odin lead-mine, at Castleton in Derbyshire; at St. Bernard's Well near Edinburgh; at the coal mines of Montrelais in France, at Neufchatel, and in the Island of Zante.

Elastic Curve. In Mechanics, as originally defined by James Bernoulli, the figure which a thin horizontal elastic plate would assume if one end were fixed and the other loaded with a weight. The equation of the curve to rectangular coordinates, of which the origin is at the fixed extremity and the abscissa axis horizontal, is $y = b(3ax^2 - x^3)$, where b is a small quantity depending on the ratio of the attached weight to the elastic force of the plate whose length is a.

Elasticity (from Gr. ἐλαύνω, *I draw*). In Physics, that property which certain bodies possess of recovering their primitive form and dimensions after the external force by which they have been dilated or compressed or bent is withdrawn.

The theory of elasticity must be deduced from some hypothesis respecting the constitution of matter. The simplest and most general view which can be taken of the subject is, that all matter is composed of indefinitely small parts or *molecules* acted upon by attractive and repulsive forces. From the combined action of these two forces result the different forms of matter with their varied physical properties.

This view of the constitution of bodies supposes that the molecules are not in contact, but at a certain distance from each other, which, though it is to be regarded as infinitely small in comparison of any distance appreciable by our senses, admits nevertheless of increase and diminution. When a body is in a state of rest, the opposite forces which any two of its contiguous molecules exercise on each other are in equilibrium. The energy of the forces also depends on the distance between the two molecules, or, in mathematical language, is a function of that distance. If the distance be increased within the limits of the action of the forces, both forces are diminished; and if the distance is diminished, both are increased, but not in the same proportion. If the interval at which the two forces balance each other be diminished, the repulsive force becomes stronger than the attractive force, and the two molecules are repelled from each other; on the contrary, if the distance be increased, the attractive force acquires the superiority, and the molecules are drawn towards each other.

Let us now suppose a solid body, of which all the molecules are in a state of equilibrium, to receive the impression of an external force. The operation of the force is to produce a change in the distances of the molecules at the

surface, in consequence of which the equilibrium is disturbed, and the molecules thrown into a state of vibration. This vibration is communicated to the interior molecules; and the body, under the action of the external force, undergoes a certain change of form. The molecules at the surface, which receive the impulse, transmit it to those in the interior of the body, and are reacted on by them with an equal force. In this manner the action is propagated through the whole mass, until it is destroyed by another exterior force, or by the resistance of an obstacle to the motion of the body itself.

Elasticity is perfect when the body exactly recovers its primitive form, after the force by which it is bent or compressed or dilated has been removed, in the same time as was required for the force to produce the alteration. This perfect elasticity is, however, not found in any of the bodies of nature; the aëriform fluids or gases are those whose elasticity approaches the nearest to it.

The principal phenomena of elastic bodies are the following: 1. That an elastic body (the elasticity being supposed perfect) exerts the same force in endeavouring to restore itself as that with which it was compressed or bent. 2. The force of elastic bodies is exerted equally in all directions, but the effect chiefly takes place on the side on which the resistance is the least. 3. When an elastic solid body is made to vibrate by a sudden stroke, the vibrations are performed in equal times, to whatever part of the body the stroke may be communicated. Thus, sonorous bodies always emit sounds of the same pitch; and the difference of the pitch depends on the greater or less frequency of the vibrations of the sonorous body.

Elasticity, Surface of. The central pedal of an ellipsoid. [PEDAL SURFACES.] The surface was so called by Fresnel (*Mémoires de l'Institut*, vol. vii.), who found its radii vectores to be proportional to the square roots of the elastic forces, in the directions of these radii, of the luminous ether around any point of a crystalline body. These radii vectores, therefore, are also proportional to the velocities with which waves are propagated whose ether-particles vibrate in directions parallel, respectively, to the radii vectores in question. By means of the elastic surface, therefore, we are enabled to explain the phenomena of double refraction, since the angle of refraction depends upon the velocity of the wave. On this subject the reader may be referred to Dr. Lloyd's *Elementary Treatise on the Wave Theory of Light*, London 1857.

Elater (Gr. ἐλατήρ, *a driver*). A Linnæan genus of Coleopterous insects, now the type of an extensive family of the Serricorn Coleoptera. The *Elateridæ* may be distinguished from the other Serricorn beetles by the presence of a strong, short, and often slightly curved spine, projecting from the posterior margin of the prosternum, and of a depression just above the origin of the second pair of legs adapted for the reception of the preceding spine. An *Elater* may be recognised on a distant view from the particular use to which it puts the above described sternal modifications. If a beetle be seen to fall upon its back, and instead of making the ordinary attempts to set itself upon its legs, bends its head towards its tail, raising this part, and then suddenly springing into the air, and repeating the action until it has fallen upon its feet, such a beetle may be recognised at once as a species of one or other of the numerous subgenera of the *Elateridæ*. This leap is due to the rebound occasioned by the sudden disengagement of the sternal spine from its socket. One of the species of *Elater* proper (*Elater noctilucus*) is the common fire-fly of the tropical parts of America. Its luminosity is emitted by two round convex yellow spots situated at the sides of the thorax. The *Elateridæ* generally are vegetable feeders; the larvæ devour decayed timber; the perfect insects feed on flowers or other soft and living parts of vegetables.

Elaters. In Botany, the loose spiral fibres that are contained, together with the sporules, in the conceptacles of *Jungermannia* and *Marchantia* &c.

Elaterium (Gr. ἐλατήριος, *driving away*). This substance, commonly called *extract of elaterium*, is obtained from the fruit of the *Ecbalium agreste*, formerly called *Momordica Elaterium*, or Squirting Cucumber. This, if gathered a little before it ripens, and the juice gently expressed, deposits a green sediment, which is collected and dried. In the dose of from one-eighth of a grain to a grain, good elaterium operates as a drastic purge, bringing away from the bowels a large quantity of watery secretion; it is seldom prescribed except with a view of diminishing the collection of fluid in cases of dropsy.

ELATERIUM. In Botany, a term invented by Richard to denote that kind of fruit which is found in *Euphorbia*, consisting of three or more carpels, consolidated when young, but bursting with elasticity when ripe. A synonym of Coccum.

Elatinaceæ (Elatine, one of the genera). An order of small insignificant water or marsh plants, belonging to the Rutal alliance of hypogynous Exogens, and of no particular interest or value.

Elayl. [ETHYLENE.]

Elbow (A.-Sax. elnboga, elboga; Lat. ulna; Gr. ὠλένη). The angle in each of the two cables by which a ship is moored, made by the intertwisting of those cables consequent on the swinging of the vessel. To form an elbow, one cable must cross the other cable, and then reach the ground on the same side as it leaves the ship's bow. [HAWSE.] Also a term for a sudden turn in a line of coast or course of a river.

Elbows. In Architecture, the upright sides which flank any panelled work, as in windows, below the shutters, &c.

Elcaja. An Arabian tree, the fruit of which is emetic, and is employed in an ointment for

the cure of the itch: it is the *Trichilia emetica* of botanists.

Elders. Certain laymen who, according to the constitution of the Presbyterian church, form a council of which the minister is the moderator, and discharge the functions of a spiritual court. They also assist the minister in the management of the concerns of the parish, attending to the interests of the poor, like the deacons of the primitive church. Among the Jews, elders were those persons most distinguished for age, rank, and wealth, who formed the council of the people. [PRESBYTERS.]

Eleatic Philosophy. A system owing its origin to Xenophanes, a native of Elea (in Latin *Velia*), who lived about the year B.C. 530. The most celebrated of his followers were Parmenides and Zeno, also natives of Elea. The dialectical character of the principal systems of antiquity may be said to owe its existence to the Eleatics. The tendency of their speculations was the direct contrary of that which distinguishes the Ionic school. While the latter fixed their attention on outward nature, and strove to discover the laws which regulate its progress, Xenophanes and his disciples confined their thoughts to what they conceived to be the only objects of real knowledge—the ideas of God, or Being as it is in itself. The world of succession and change, which they designated under the title of *that which becomes* (*τὸ γιγνόμενον*), they held to be utterly vain and illusory; the very conception of change itself seeming to them to involve a contradiction. Time, space, and motion they regarded as mere phantasms, generated by the deceiving senses, and incapable of scientific explanation. They were consequently led to distinguish between the pure reason, the correlative of Being, and in one sense identical with it, and opinion or common understanding, the faculty which judges according to the impressions of sense. Parmenides, in particular, was the author of a philosophical epic, the two books of which treated respectively of these two modes of thinking. For a full account of all that can be gathered from remaining fragments of this rigid system of rationalism, the reader must consult the German writers on the subject; in particular Brandis and Ritter, in their histories of philosophy. Frequent allusion is made both by Plato and Aristotle to the Eleatic doctrines, the authors of which are mentioned by both those philosophers in terms of evident respect and veneration. Plato has made their system the subject of a whole dialogue, entitled the *Parmenides*; perhaps the most striking specimen of dialectic subtlety which Grecian philosophy affords. (Thirlwall's *History of Greece*, vol. ii. c. xii.; Grote's *History of Greece*, part ii. ch. lxvii.)

Elecampane. The vulgar name of the *Inula Helenium*. It is an aromatic bitter, and was formerly regarded as expectorant; whence the monkish line,

Enula campana reddit præcordia sana.

A coarse candy, composed of little else than coloured sugar, is sold under the name of elecampane.

Elect (Lat. electus, *chosen*). Some functionaries are so termed during the period between their appointment and some act which is necessary to ratify it; as a bishop after election and before consecration.

Election. In Law, this term denotes that a man is left to his own free choice to take or do one thing or another; as, where a man has two forms of action by which he may recover his right, it is within his election to choose that according to which he will proceed; or where, as in some cases, he has an election between several parties, against any of whom he may prosecute his suit. Where there are coparceners of lands, on partition the eldest sister has the election.

ELECTION. In Theology, the choice made by God of certain individuals of the human race to enjoy peculiar privileges and blessings. In the Old Testament, election is spoken of as national, not individual. The later doctrine of the arbitrary election of certain persons to eternal life—something resembling which is attributed to the Basilidians, Valentinians, and other early heretics—cannot easily be traced in the writings of any father of the church before Augustine, who embraced it with ardour, but appears to have varied in his opinions respecting it. It is rigidly laid down in his treatise *De Dono Perseverantiæ*. Calvin, in modern times, was its great reassertor, and declared: 'We were elected from eternity, before the foundation of the world, from no merit of our own, but according to the purpose of the divine pleasure.' (*Inst.* iii. c. 14, s. 5.) It became a fundamental article of belief in Calvinistic churches. The synod of Dort was expressly convened to vindicate the doctrines of election and predestination against Arminian tenets (1615). The language of the church of England, on this point, admits of a variety of interpretations; but during the prevalence of Calvinism in the higher clergy, and especially in the university of Cambridge, under Archbishop Whitgift, an attempt was made to define her tenets more strictly. The Lambeth articles, agreed to in 1595 by a portion of the clergy, assert that 'God from eternity hath predestinated certain men unto life, certain He hath reprobated.' But these articles were not ratified, and have no authority. [CALVINISM; PREDESTINATION.]

Elective Affinity. Signifies the order of preference, as it were, in which substances combine: thus, if nitric acid be added to a mixture of lime and magnesia, it will *elect* or choose to combine with the lime in preference to the magnesia. [AFFINITY, CHEMICAL.]

Elective Governments. Governments in which all functionaries, from the highest to the lowest, are chosen by the suffrages of a greater or less number of citizens. Of these the government of ancient Athens, and in modern times that of the United States, will serve as examples. When the functionaries of

an elective government are chosen by a very great number, it is a democracy; and when by a comparatively small number, it is either an aristocracy or an oligarchy.

Electors (Lat. elector, *a chooser*; Ger. chur- or kur-fürsten). Those princes of the old German empire who had a voice in the election of the emperor. These were originally (A.D. 1256) seven; Mentz, Trèves, and Cologne—ecclesiastical; Bohemia, Brandenburg, Saxony, and the Elector Palatine—lay; but to these Bavaria was added soon after their institution. In 1692 this dignity was conferred on the dukes of Brunswick-Luneburg, who were afterwards styled electors of Hanover; and, at different periods during the last century, on the princes of Salzburg, Wurtemberg, Baden, and Hesse Cassel. But on the extinction of the German empire in 1806, the title of *elector* was merged in that of *king*, grand duke, &c. &c., by all the German states except Hesse Cassel, whose sovereign is still designated *elector*. The electors had various privileges, both general and special.

Electric Column. An electric instrument invented by De Luc, consisting of numerous alternating discs of silver leaf, zinc leaf, and paper. [ELECTRICITY.]

Electric Fishes. The species of the class *Pisces* are so called which have the power of discharging electric shocks; the most remarkable are the *Torpedo*, *Gymnotus* or electrical eel, and *Silurus*, or *Malapterurus electricus*.

Electric Light. The immediate source of this, as of other artificial lights, is heat, but the heat is produced from the force of electricity; hence the term *electric* light. The electricity is generally evoked by the chemical reaction of a metal and an acid, the combination being termed a *battery*. From opposite ends of the battery the opposite kinds of electricity are conducted by wires which are terminated by pencils of hard coke. When these pencils are brought within a short distance of each other, the opposing electric currents rush together to form again neutral electricity, and this act gives rise to an enormous amount of heat. The heat is even sufficient to ignite the intermediate stratum of air to a point at which it evolves light; but this amount of light is insignificant compared with that given out by the ignited ends of the coke pencils and by the particles of carbon which are thrown off by one of these pencils. From these ignited portions of coke emanate the rays constituting this most intense and beautiful of all artificial lights.

Electric Telegraph. [TELEGRAPH, ELECTRIC.]

Electrical Eel. [GYMNOTUS.]

Electricity. This term is derived from the Greek ἤλεκτρον, *amber*, the substance in which the property of attracting light substances after friction was first observed.

This truly extraordinary power of matter, independent of the interest that always belonged to it, has of late years acquired much importance from its influence over chemical phenomena, and its connection with those of magnetism. When a clean glass tube is rubbed with the dry hand, or with a piece of silk, it first attracts and then repels any light substances—such as feathers, bran, or little pieces of paper—which are brought near it; a stick of sealing-wax rubbed upon dry flannel exhibits the same appearances, and, to a superficial observer, seems to be exactly in the same state as the glass; and they are said to be electrically *excited*. But, on more close examination, it is found that when light bodies are *repelled* by excited glass, they are attracted by excited sealing-wax, and vice versâ, so that the glass and wax are said to be in *opposite electric states*; and hence the terms *vitreous* and *resinous* or *positive* and *negative* electricity. But these two states are always coexistent: thus when glass is rubbed by silk the glass becomes positive, but the silk becomes negative; and in the case of sealing-wax rubbed by flannel, the wax is negative, but the flannel is positive.

A similar excitation of electricity is seen in an infinity of other cases: as when we rub a cat's back with the hand, or when a piece of silk ribbon is drawn briskly through the fingers, or a sheet of paper rubbed with a piece of caoutchouc, or a metal rod with a silk handkerchief. These, and other extraordinary phenomena connected with them, are hypothetically referred to the presence of a peculiar form of matter called the *electric fluid*, which is supposed to appertain to all matter, but to become evident only when in redundance or deficiency. When glass is rubbed with silk, the equilibrium of the electric fluid is disturbed, and the silk imparts electricity to the glass; hence the former, losing electricity, becomes *minus* or negative, and the latter, acquiring it, becomes *plus* or positive. This is commonly called *Franklin's theory*, having been proposed and defended by that celebrated electrician. Others have assumed the existence of *two fluids* as essential to the explanation of electrical phenomena; both equally subtile, elastic, and universally diffused, and each highly repulsive as to its own particles, and attractive to those of the opposite kind. Electrical quiescence is referred to the combination of these fluids, and their consequent mutual neutralisation; and electrical excitation is the consequence of either being free or in excess. It is supposed that they are separated by friction, and by all those other causes which give rise to the appearance of free electricity. Either of these hypotheses may be adopted as facilitating the explanation of electrical phenomena, and as conferring meaning on terms which would otherwise be unintelligible; of the two, the simpler, or that which refers the phenomena to one fluid, is perhaps the most generally applicable. Both are apparently equally consistent with facts; but the actual idea of any *fluid*, or form of matter, as the cause of electrical phenomena, is now utterly repudiated by all electricians.

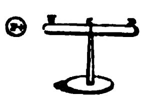
There are two series of distinct phenomena

presented by electrified bodies: the one seems to result from the accumulation of electricity upon the surfaces of bodies, and is commonly included under the term *electricity of tension*, these phenomena being well exhibited by the common electrical machine and its prime conductor. It affects all neighbouring bodies, and they are thrown by it into a polar electrical state by what is termed *induction*: it has a tendency to pass off in sparks through the air, or gradually to escape from points. The thunder storm furnishes a magnificent specimen of this state of electricity. The other state of sensible electricity is that exhibited by *electricity in motion*; as when a current of electricity is passing through a wire or other conducting medium; in this case a vast *quantity* of electricity may be concerned in the phenomena without any apparent *intensity*; but, whilst the current is continuous, it produces magnetic phenomena of a most extraordinary character; and, when the perfect conductor is broken by the intervention of certain other media, they suffer in some cases chemical decomposition, and in others become heated, and even ignited. The phenomena of electricity in motion are best exhibited by the voltaic apparatus.

In all electrical experiments, remarkable differences are observed in respect to the transfer of the electric fluid through different bodies —some, as the metals, allowing its free and nearly unimpeded passage through their substance, while others receive and retain it more superficially, such as glass, resin, and other substances, which exhibit attractive and repulsive powers when rubbed. Hence the division of bodies into *conductors* and *non-conductors*.

Many most important electrical phenomena depend apparently upon *induction*, a subject which has been ably studied by Faraday (*Phil. Trans.*). We shall here enter into such details only as are required to render some of the principal terms employed in discussing electrical phenomena intelligible.

If P + represent a metallic sphere in a highly positive electric state, and N P a metallic *conductor* in its vicinity *insulated* upon a glass stem; it will be found that the extremity N of N P is *negative*, whilst the other extremity P is *positive*, and that these opposite electricities are greatest at the extremities of the conductor, and gradually diminish towards the centre line C, which is neutral. This extraordinary state of excitation in N P is entirely dependent upon the proximity of P +; for if P + be withdrawn, N P loses all appearance of electricity; and the degree of excitement in it is directly proportional to the extent to which P + is excited, and (within certain limits) to its nearness to N; so that fluctuations in the electricity of N P will be observed in proportion as P + is brought towards or removed from N, provided they are not brought into *contact*, and that no *spark* passes. These phenomena have been theoretically explained upon the supposition that the free electricity in P + disturbs the equilibrium of the neutral electricity of N P, and by repelling it from N to P leaves the former *minus* and the latter *plus*. Or, if we assume the existence of two electric fluids, then the free positive electricity of P + *repels* the positive fluid of N P and *attracts* its negative fluid, throwing it into an *electro-polar* state. If N P, instead of being insulated, be connected by its extremity P with the ground, the accumulation at P is prevented, whilst N retains its deficient or negative state; or, upon the other theory, the positive fluid at P is neutralised by a supply of negative fluid from the earth; and if, after having effected this by momentarily touching N P with the finger, we suddenly remove P +, the insulated conductor N P will be left with an excess of negative electricity.



It will be obvious from the above statement that when light bodies, especially if they be conductors, are attracted by electrified surfaces in their vicinity, they are thrown by induction into opposite electrical states; and when the hand is brought near the excited conductor of the electrical machine, it becomes negative, and remains so till the equilibrium is restored by the passage of a spark; which phenomenon is supposed to be the result of the combination of the two electric fluids.

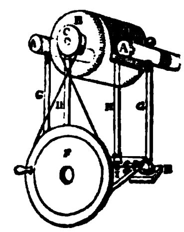
Many important phenomena of electrical accumulation are explained by reference to the principles of induction, and among them the action of the *Leyden jar* or *phial*. A thin glass jar or bottle, A, is coated inside and out, to within three or four inches of its mouth, with some conducting substance (tinfoil, being especially convenient for the purpose, is generally used); and a metallic rod projecting a few inches from the aperture, and surmounted by a brass ball, B, communicates with the interior coating.

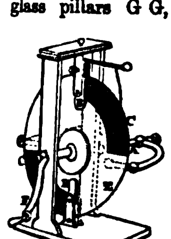
When the ball is applied to the prime conductor of the electrical machine, and the outer coating communicates with the ground, the interior acquires a positive and the exterior a negative charge; and on making a communication by means of a conductor between the inner and outer coatings, the electricities are annihilated with the production of a bright spark and explosion, and by a most disagreeable sensation, called the *electric shock*, if the body be made part of the *circuit*. When several jars are so arranged that their interior and exterior coatings are all separately connected, the assemblage constitutes the *electrical battery*.

In the common *electrical machines*, electricity is excited by the *friction* of the plate or cylinder of glass upon the cushions or rubbers; and the glass becomes positive, communicating the same state to the opposed conductor, generally termed the *prime conductor* of the machine; while the rubber becomes negative, and is sometimes connected with a second conductor.

The following figures represent the two common forms of the electrical machine. The first

is the *cylinder* machine. B is the glass cylinder, which is made to revolve upon its axis by the multiplying wheels F, C, the necessary friction for the electric excitation being produced by the cushion and silk flap D. A A are the positive and negative conductors: the latter, bearing the cushion, is adjusted as to its requisite pressure upon the cylinder by the screw at E. The conductors are respectively supported and insulated by the glass pillars G G, which should be coated with lac varnish; and the axis of the cylinder rests upon the pillars H H, which are also of glass. The second figure represents the *plate* machine, in which A is the prime conductor, borne by a stout glass stem which is attached to the frame of the machine. B B are the upper and lower pairs of cushions, by which, together with the silk flaps C C, the necessary friction is obtained. E is the disc of plate glass which is made to revolve upon its axis by the winch, F. In this machine, as the cushions or rubbers are not insulated, the negative electricity cannot be separately accumulated or exhibited, as in the cylinder machine.





There are many other and highly important causes of electric excitation besides those above adverted to; such as contact of different metals [GALVANISM], chemical action [VOLTAIC ELECTRICITY], change of temperature [THERMO-ELECTRICITY], and magnetism [MAGNETISM and ELECTRO-MAGNETISM].

Electro-ballistic Apparatus. An instrument for determining by electricity the velocity of a projectile at any part of its flight. The projectile passes through a screen, thus breaking a current of electricity, and setting in motion a pendulum, which is arrested on the passage of the projectile through a second screen. The distance between the screens being known, the arc through which the pendulum vibrates measures the time due to the projectile's flight between the screens.

Electro-biology (Gr. ἤλεκτρον; βίος, *life*; and λόγος, *description*). A term recently applied to certain mental phenomena, supposed by some to be produced by various applications of Mesmerism to the human body.

Electro-chemistry. That branch of chemical science describing the especial applications of electricity as a chemical agent.

Electro-dynamics (Gr. ἤλεκτρον, and δύναμις, *power*). The phenomena of electricity in motion.

Electro-magnetic Clock. The discovery of the mutual relations of electricity and magnetism by Oersted in 1819, necessarily led to the construction of the *electro-magnet*; and amongst its numerous applications, that to *timekeepers* was perhaps one of the most obvious. A bar of iron of any required form may have any amount of magnetism conferred upon it by proper adjustments of an electric current; and inasmuch as the magnetic power ceases the moment that the electric current is discontinued, so we are enabled to render a bar of soft or pure iron a strong magnet at one moment, and at the next to withdraw all such force. It will be further obvious, that these magnets may be made and unmade at any distance, by an adequate extent of metal wire; so that at one and the same moment a magnet may be made and unmade at London and at Liverpool, and simultaneously, if we please, with the vibrations of the magnetic needle which announce the signals of the electric telegraph. And, of course, the magnet may be made alternately to lift and drop a weight, or to bend and release a spring, or to raise and depress a lever. Bearing these matters in mind, the *principle* of electric clocks will be intelligible, without entering into minute details respecting their varied mechanism.

There are several ways in which electro-magnetism has been applied to these purposes; one of the first consisted in fixing upon the arbor or axis of the seconds wheel of a clock a wheel or disc of metal, the circumference or edge of which was divided into sixty alternating divisions of metal, and of ivory or wood, the metal being a conductor, and the ivory or wood a non-conductor of electricity. A small platinum peg, or point, was kept in contact with this divided edge, so as, by the revolution of the wheel, to be alternately in contact with the conducting and non-conducting surfaces, and so connected with a voltaic series as alternately to admit and resist the passage of an electric current. In this way, supposing the clock in question to be keeping accurate time, one or more electro-magnets placed anywhere in the circuit of the conducting wire would be made and unmade at each succeeding second. Now, it is easy so to connect an electro-magnet with a lever, as to give motion to a wheel and axle, and to cause it to revolve so as to indicate seconds, and when in communication with a proper train of wheels, to move the minute and hour hands of a clock; and this secondary, or *electro-magnetic clock*, would of course be regulated in its movements by the alternating electric current derived in the way we have mentioned from the original timekeeper. Every clock, therefore, upon the circuit, would show the same time as that shown by the regulator; and in this way, one good regulator may be made to preside as it were over any number of electro-magnetic movements, each of which will indicate the same time.

Another form of the electro-magnetic clock is that in which the pendulum is itself kept in

action by electro-magnetism, and through it the other movements of the clock are sustained; and this is effected either *directly*, as in Bain's clock, or *indirectly*, as in Shepherd's clock. In Bain's clock, the pendulum, at each vibration, moves a light slide by which the electric current is alternately completed and broken, and by which magnetism is alternately conferred upon and abstracted from a coil enclosed in a heavy hollow brass case or tube which constitutes as it were the bob of the pendulum, and on either side of which are the poles of two common or permanent bar magnets, which alternately attract and repel the coil of the bob, as it is magnetised and demagnetised by the alternate presence and absence of the electric current. These clocks have been kept in motion by electric currents derived from a zinc plate buried in damp earth, and so far, therefore, independent of the usual forms of a voltaic battery, in which the electricity is derived from the action of dilute sulphuric acid upon zinc.

Another form of electric clock is that invented and patented by Mr. Shepherd; the large clock at the Great Exhibition of 1851, in Hyde Park, was of this description. In this clock, electro-magnetism is the sole moving power, its force being employed, not only to give impulse to the pendulum and to propel the ordinary movement of the clock, but also to perform the striking of the hour, no auxiliary weights or springs being employed. The pendulum is so arranged as to make and break the electric circuit, and make and unmake a horseshoe magnet at each vibration. Each time that the magnet is made, it attracts its armature, which lifts certain levers; one of these is concerned in raising a weighted lever, and causing it to be held up by a latch or detent; the magnet is then unmade in consequence of the pendulum breaking the circuit, and its armature is released, when the pendulum lifts the latch and allows the weighted lever to fall, which, in falling, strikes the pendulum so as to give it a certain adequate impulse; then the circuit is again completed, the armature attracted, the levers moved, the weight raised and held by the detent; another vibration breaks the circuit and then releases the armature; the pendulum then raises the detent, the weight falls, and in falling its arm strikes the pendulum and gives it its impulse, and so on.

But the pendulum at each vibration not only makes and breaks the electric circuit which maintains its own action, but also, and simultaneously, that of another battery, of which the duty is to make and unmake the electro-magnets belonging exclusively to the clock or clocks which are upon this circuit. These electro-magnets act upon the extremes of one or more horizontal bar magnets so as alternately to attract and repel their opposed poles, which carry upon their axes the pallets, by the alternating motion of which to the right and left the ratchet-wheel is propelled onwards at the rate of a tooth each second; and the axis of this ratchet-wheel carries the pinion which moves the other wheels of the clock.

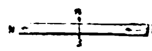
The circuit of the battery connected with the *striking* part of the clock, is only completed once in each hour, and is connected with an electro-magnet so arranged as by means of a proper lever to pull the ratchet-wheel attached to the notched striking-wheel one tooth forward every two seconds, and each tooth is accompanied by a blow on an electro-magnetic bell. The number of blows depends upon the notched wheel, the spaces in the circumference of which are adapted to the number to be struck; and when this is complete, a lever falls into the notch, and in so doing cuts off the electric current, which is not re-established through the striking electro-magnet till the completion of the next hour, when a peg upon the hour-wheel pushes the striking-lever forward so as to cause it to be depressed by a similar peg on the minute-wheel.

Electro-magnetic clocks are peculiarly fitted for large establishments where many dials, each indicating the same time, are required: the pendulum by which the whole series is controlled is placed in some safe and quiet place, and the only requisite precaution for maintaining them in order consists in careful attention to the conditions and functions of the voltaic apparatus, or source of the electric current. Smee's batteries, as they are called, consisting of amalgamated plates of zinc in proper connection with plates of platinum or platinised silver, and immersed in dilute sulphuric acid, or in sand moistened with the acid, are generally used; the number and dimensions of the plates or cells depending upon the extent of wire which the electric current is required to traverse, and care being taken that the chemical action of the acid upon the plates is as small and feeble as is consistent with the object in view. These clocks are also importantly useful upon lines of railway, and for a variety of other purposes, more especially when some few difficulties attending their management and maintenance are overcome.

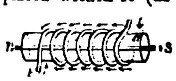
Electro-magnetism. When a current of electricity is traversing any substance, such for instance as a metallic wire, or when electricity is *in motion*, magnetism is at the same time developed. This fact was first observed by Professor Oersted of Copenhagen in 1819. If a magnetic needle be brought near a wire through which an electric current is passing, the needle will immediately deviate from its usual position, and assume a new one, dependent upon the relative position of the needle and the wire. On placing the electric wire *above* and parallel to the magnet, the pole next the negative end of the battery always moves to the west; and when the wire is placed *under* the needle, the same pole turns to the east. When the electric wire is on the same horizontal plane with the needle, no declination takes place; but the magnet shows a disposition to move in a vertical direction, the pole next the negative side of the battery being

depressed when the wire is to the west of it, and elevated when it is to the east.

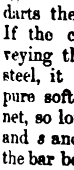
The magnetic phenomena of a wire transmitting electricity are such as appear to depend upon the circulation of magnetism at right angles to the electric current, so that if N P represent the wire transmitting



a current of electricity in the direction of the horizontal darts, a current of magnetism will be established in the direction of the vertical dart, appearing to move round the axis of the electric current; hence the term *vertiginous* or rotary magnetism, applied to these phenomena; and hence the motion of the pole of the magnet round the electric wire, or of the electric wire round the pole of the magnet, when they respectively are so arranged as to be able to move freely in any direction. If a steel needle be placed in contact with the electric wire, and parallel to it, it acquires opposite magnetisms upon its two sides; but if it be placed at right angles to the connecting wire, that is, to the electric current, it becomes polar, and permanently magnetic. If the electric wire be twisted into a spiral, and the steel needle placed within it (as in the cut), it is retained



there, and becomes a more powerful magnet in consequence of the repetitions and direction of the electric and magnetic currents, as will be evident from the annexed figure, where *a* represents a glass tube, with the wire *n p* conveying the electric current twisted round it; the darts at the ends of which show the ingress and egress of the electricity, and the transverse darts the direction of the magnetic current. If the cylinder round which the wire conveying the electric current is twisted be of steel, it becomes a permanent magnet; if of pure soft iron, it becomes a temporary magnet, so long as the electric current is in motion, and *s* and *n* are powerfully opposed poles. If the bar be bent, as in the annexed cut, a power-



ful horse-shoe magnet is obtained when the ends P N of the insulated copper wire twisted round it are connected with the voltaic circle; a single pair of plates is sufficient for the purpose, but the effect may be enormously augmented by additional pairs and by increasing the number of coils of wire round the bar.

Electro-metallurgy. The electro-chemical precipitation of the metals, as applied to various purposes in the arts. For a description of these processes, see Smee's *Elements of Electro-metallurgy.*

Electro-negatives. Those substances which in electro-chemical decompositions make their appearance at the *anode* or electro-positive pole. The term has reference to the mutual attraction of bodies dissimilarly electrical, and hence those which appeared to be attracted by the positive pole in the voltaic circuit were presumed to have an inherent *electro-negative* state.

Electro-positives. Bodies appearing in electro-chemical decompositions at the *cathode* or electro-negative pole.

Electrode (Gr. ἤλεκτρον, and ὁδός, *a way*). The surfaces by which electricity passes into and out of different media have been called *electrodes*. They are also termed the *poles* of the voltaic battery or pile.

Electrolysis or **Electro-chemical Decomposition** (Gr. ἤλεκτρον, and λύω, *I dissolve*). The separation of the elements of a compound by the transmission of electricity.

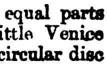
Electrolytes (Gr. ἤλεκτρον, and λύω). Substances susceptible of direct decomposition by the action of the electric current: hence, also, the verb *electrolyse*, i. e. to resolve compounds into their elements by the agency of electricity. Faraday has shown that in many supposed cases of electrolysis, the evolution of elements is the consequence of a secondary action; the sulphur, for instance, which is thus evolved at the negative pole from sulphuric acid, is the result of the evolution of hydrogen at that pole; in all cases of true electrolytic action, sulphur appears at the positive pole.

Electrometer. This term has been applied indiscriminately to instruments detecting electrical excitation [ELECTROSCOPE], and to those which are calculated to measure differences in the amount of electrical force. In Coulomb's torsion electrometer, the force opposed to that of electricity is the resistance to twisting offered by an elastic thread. In Henley's quadrant electrometer, the electric force is measured by the amount of repulsion which it produces upon a pith ball attached to a straw suspended from the centre of a graduated arc. [ELECTRICITY.]

Electromotor or **Electromotive Force.** Terms applied to the developement of electricity in voltaic arrangements.

Electron (Gr.). By this name the ancient Greeks denoted (1) amber and (2) a metallic substance consisting of four parts of gold and one part of silver. [ELECTRUM.]

Electrophorus (Gr. ἤλεκτρον, and φέρω, *I carry*). This instrument consists of a resinous plate (A), which may be made of equal parts of shell-lac and resin, with a little Venice turpentine, melted and cast into a circular disc of somewhat less than an inch thick, and from six to ten inches in diameter; it should rest upon a metal plate or sheet of tinfoil: upon its upper

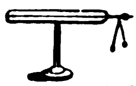


surface is placed a somewhat smaller brass plate (B), with a glass handle. When the resinous plate is *excited*, by rubbing it with a warm and dry flannel, and the metallic cover put down upon it, a spark of negative electricity may be drawn from it, and if it then be raised it affords a second spark of positive electricity. On replacing the cover, and again touching it, it gives a negative spark, and on again raising it a second positive spark, and these sparks thus obtained may be repeated any number of times, so that the instrument forms a useful and portable electrical machine: it well illustrates

the phenomena of *induction*, and is elegantly applied to inflame a jet of hydrogen gas in Volta's *inflammable air lamp*.

Electropolar. [INDUCTION.]

Electroscope. Many instruments have been devised for the detection of feeble electrical



charges: the simplest consists of two small pith balls suspended by fine wire or thread from one end of an insulated conductor: upon the principle that bodies similarly electrified repel each other, these *diverge* upon the re-

ception of minute quantities of electricity. Two thin slips of gold leaf are also similarly applied; and, to prevent the influence of the agitation of the air upon them, they are suspended in any convenient way under a glass shade. The other forms of electrometers generally act upon the same principle, being adjusted to the varying degrees of quantity and intensity.

Electrotint. An art by which drawings are made with any substance insoluble in the solution of sulphate of copper. When the design is completed, the plate is immersed in the solution, and a reverse made by the electro-coppering process [VOLTATYPE] ready for the printer.

Electrotype. An impression of a medal, or bas-relief, obtained by electric precipitation. [VOLTATYPE.]

Electrovital Currents. Two electric currents are supposed by some physiologists to move in the nerves of animals: the one external and cutaneous, moving from the extremities to the *cerebro-spinal* axis; the other internal, and proceeding from that axis.

Electrum (Gr. ἤλεκτρον). A natural alloy of gold and silver in the proportion of two of gold to one of silver. It is found in tabular crystals and imperfect cubes of a silver-white colour in Siberia, Norway, Transylvania, California, and some other gold-mining districts. [ELECTRON.]

Electuary. This term is generally applied to powders mixed up with syrup, so as to be of about the consistency of treacle. *Lenitive electuary*, or confection of senna, is a celebrated preparation of this kind; it is constituted of powdered senna, coriander seeds and sugar, mixed with the pulp of cassia, prunes, and figs, and decoction of liquorice.

Eledone (Gr. ἐλεδώνη). A name applied by Aristotle to a genus of Malakia or Cephalopods having a single row of suckers on each arm, and without any musky odour; it is applied in modern zoology to the same genus.

Elegit (Lat. *he has chosen*). In Law, a writ of execution, which lies for one who has recovered debt or damages; or upon a recognisance in any court against one not able in his goods to satisfy the same, directed to the sheriff, commanding him to make delivery of a moiety of the party's land, and all his goods except beasts of the plough. The creditor holding the moiety of the land until satisfaction is termed tenant *by elegit*. [EXTENT.]

Elegy (Gr. ἔλεγος). The name given in modern times to a species of poetical composition of a mournful character. But though this signification of the term tallies with the etymology usually given (Gr. ἒ, and λέγειν, *to cry alas*), the expression *elegy* among the Greeks and Romans had a much wider meaning. Thus among the former it embraced equally the warlike verses of Tyrtæus, the melancholy effusions of Mimnermus, and the aphorisms of Theognis and Solon; while among the latter it comprehended the miscellaneous themes of Ovid, Propertius, Tibullus, and Catullus.

Elements (Lat. elementum). The old philosophers applied this term to imaginary principles of matter; such as fire, water, earth, and air. The elements of the alchemists were salt, sulphur, and mercury. The term *element* is now used as synonymous with *simple body*.

ELEMENTS. In Astronomy, are the data necessary to compute the place of a planet, satellite, or comet. [SOLAR SYSTEM.]

Elemi. A resinous exudation, probably yielded by *Icica Icicariba*, *Elaphrium elemiferum*, and *Canarium commune*. It yields a volatile oil on distillation. It is used in ointments, giving them a gently stimulating character, and adding to their viscidity. The *compound elemi ointment* of the Pharmacopœia is a good preparation of this kind, and resembles the *yellow basilicon* of old pharmacy.

Elenchus (Gr. ἔλεγχος). [SOPHISM.]

Elephant, White. A Danish order of knighthood of great antiquity: the number of knights is limited to thirty, besides members of the royal family.

Elephantiasis. A disease affecting chiefly the legs and feet, which, becoming rough, scaly, and swollen, have been compared to the feet of the elephant: the skin gets thick, unctuous, and insensible, and the limb occasionally attains an enormous size.

Elephas or **Elephant** (Gr. ἐλέφας). The generic name of the most gigantic of existing quadrupeds. They are characterised essentially by having grinders composed of alternating vertical plates of ivory, enamel, and cementum, and two tusks in the upper jaw: they are also the only living Mammalia which have a proboscis or trunk longer than the head. It is inferred from the structure of the skull that the extinct Mastodons, which have grinders of a more simple structure, also possessed a long proboscis; and accordingly Cuvier includes the genus *Elephas* and *Mastodon* in a particular family of Pachyderms called *Proboscidians*. Of the true genus *Elephas* there are two living and a greater number of extinct species. The Indian elephant (*Elephas indicus*, Cuv.) differs from the African species in its greater size, in the skull being higher in proportion to its length, and as having a more concave forehead. The Indian elephant has also comparatively smaller ears; the skin is of a paler brown colour; and it has four nails on the hind feet instead of three. The elephant will breed in confinement; its period of gestation is twenty months and some days. It brings forth one

young at a birth, which derives its nourishment from two nipples placed on the inner side of the setting in of the forelegs. The perpendicular height of the Indian elephant, measured from the top of the shoulder, has not been found to exceed ten feet six inches; the ordinary height is from seven to nine feet. The Indian elephant varies as to the length of the tusks; their ends only are visible externally in the females, and there is also a race (Mooknah) in which they are straight and short in the males. In other races the males have the tusks long and curved, especially in that called *Dauntelah*. The anecdotes of the docility, sagacity, and tenacious memory of the elephant are numerous and generally known. The characteristics of the African elephant may be inferred from the account of those of the Indian species. It is usual to describe it as having a forehead convex instead of concave; but the projection is caused by the nasal bones, which are higher placed than in the Indian species; and the true front is in reality concave in the African species, but in a less degree than in the Indian. The chief external character of the African elephant is his huge ears. It is a remarkable fact that no African nation has ever subdued the elephant, or made it available for any useful purpose. For an account of the fossil elephants, see MAMMOTH. The genus has been divided into three subgenera—*Loxodon*, *Stegodon*, and *Euelephas*.

Elettaria (Elettaro, the native name). This genus of *Zingiberaceæ* yields Cardamoms. *E. Cardamomum* furnishes the Small or Malabar Cardamoms of commerce; while Ceylon cardamoms are said to be the produce of *E. major*. The seeds are used in this country for their cordial aromatic properties, which are due to a volatile oil; and in India they are chewed by the natives with their betel, and are used in bowel complaints.

Eleusine (so called from Eleusis, the home of the Eleusinian Dêmêtêr). A genus of grasses which furnishes one of the Eastern corn crops. In India, China, and Japan, *E. coracana* is much cultivated for its large farinaceous grain. It is one of the grasses having fingered spikes of flowers.

Eleusinian Mysteries. The secret religious rites performed every year in honour of Demeter (or Ceres) and Persephonê (or Proserpine) at the Attic town of Eleusis. [MYSTERIES.]

Elevation (Lat. elevo, *I lift up*). In Architecture, a geometrical representation of a building measured vertically in respect of the horizon; by the ancients it was called the *orthography*. It is only in this sense that it is technically used by architects; in general terms it is the height of the building above the ground.

ELEVATION. In Astronomy, the angular height or the altitude of a celestial object above the horizon. Thus, *elevation of the pole* denotes the arc of the meridian intercepted between the pole and the horizon.

ELEVATION. In Gunnery, the inclination of the axis of the piece above the object aimed at, to allow for the falling of the shot by reason of the force of gravity; it varies with the range.

ELEVATION. In Perspective, is sometimes used for the scenography, or perspective representation of the whole object or building.

Elevation Crater. A volcanic crater supposed to be formed by the upheaval of a mixed mass of lava and scoria already poured out in a series of horizontal beds. The result of elevation of such accumulations is assumed to be a bubble-shaped hill, such as may be found in all volcanic districts. The bubble thus thrown up is supposed to break at the top to allow of the escape of the explosive material and molten rocks within, and thus a deep cup-like depression (the crater) is left when the eruption is over and the erupting matter is exhausted.

This theoretical view of the formation of a volcano is opposed to the rationalistic view of most of the English geologists; namely, that the cone is the result of the material accumulated round the point of eruption, and has been ejected from the burning mountain in successive sheets of lava wrapping round each other. This latter view is most in accordance with the observed facts of the case.

Elevation of the Host (from Lat. hostia, *a victim*). In the ritual of the *Mass*, the lifting up of the elements immediately after consecration, for the adoration of the people.

Elevation of Rocks. As almost all rocks have been deposited, from suspension or solution in water, below the sea level, or else at a great depth beneath the surface of the solid earth, at some place where heat is able to act uniformly, they can only have been brought to their present position at some distance above the sea level by having been lifted up by some force acting from beneath. The elevation of rocks is therefore a subject of much controversy; but the reader must refer to the several articles that bear upon the considerations involved, for detailed notices. It is certain that the upheaval has not always been rapid and violent, but that it has required a very long period of time, and many concurrent causes. [EARTHQUAKE; DESCRIPTIVE GEOLOGY; AXIS OF ELEVATION; VALLEY OF ELEVATION; ANTICLINAL AXIS.]

Elevator. A surgical instrument for raising depressed portions of the skull.

Elfs (A.-Sax. Ælf) or **Fairies.** Imaginary beings, honoured more particularly by the northern nations, in whose mythology they occupy a prominent place. They were divided into two classes—the good and the bad [DEMONS]; and their exploits have given rise to a multiplicity of delightful stories. [FAIRIES.]

Elgin Marbles. A collection of ancient bas-reliefs, statues, &c., principally derived from the ruins of the Parthenon at Athens, and now deposited in the British Museum. Mr. Harrison, a northern architect of great ability, suggested to Lord Elgin, in 1797, at the period of his nomination to the embassy at Constantinople, the removal of these celebrated

works; but it was not till some time after Lord Elgin's arrival that the ministers of the Porte allowed him to detach any portion of the marbles; and about eighty cases arrived in England in 1812. In 1816 the collection was purchased by the government, upon the recommendation of a committee of the House of Commons, for the sum of 35,000*l*. They are without question the finest productions of sculpture in the world; their author is known to have been Phidias, and they represent some of the mythological fables connected with the history of Athens and the religious processions of the times.

Eliminant. In Algebra. [RESULTANT.]

Elimination (Lat. elimino, *I put out*). In Algebra, the operation by means of which, from a given system of equations, another is deduced in which one or more of the original unknown terms or facients no longer appears. Thus a system of m homogeneous independent equations in m variables, or, what is equivalent, a system of m non-homogeneous equations containing $m-1$ unknown terms, cannot be satisfied by a common system of values of these variables unless a certain relation exist between the coefficients. Elimination leads to the discovery of this relation; and the function which, equated to zero, expresses the same is called the *resultant* of the system of equations. The resultant is one of the most important of algebraical functions; a few words, therefore, with respect to its formation are necessary. [RESULTANT.]

The resultant of a system of m linear equations is the determinant, of the m^{th} order, whose constituents in any line (or column) are the coefficients, in those equations, of one and the same variable. The elimination in this case is the simplest possible; to it the more complicated eliminations may frequently be reduced.

The *method of elimination by symmetric functions* will be best illustrated by considering two non-homogeneous equations $F(x)=0$ and $f(x)=0$, of the m^{th} and n^{th} degrees respectively. In order that these equations may be satisfied by a common value of x, it is obviously necessary and sufficient that the product should vanish of the results obtained by substituting in one of the functions F, f the several roots of the other equation. Thus if $a_1, a_2 \ldots a_n$ be the roots of $f(x)=0$, then $F(a_1)F(a_2) \ldots \ldots F(a_n)=R$ will be the resultant of the two equations. It is clearly a symmetric function of the roots of the second equation, and can consequently be expressed as a function of its coefficients. [EQUATION and SYMMETRIC FUNCTION.] The degree of R in the *coefficients* of F is clearly equal to n, the degree of $f(x)$.

The modifications to be introduced in the case of two homogeneous equations in two variables, and the extension of the method to any number of equations, is sufficiently obvious. Theoretically, this method is the best, though in practice it is superseded by more expeditious ones.

Euler's method of elimination is based upon the following analysis: If the two equations have a common factor, then the same result will be obtained, no matter whether we multiply the first equation by the remaining $n-1$ factors of the second, or the latter by the remaining $m-1$ factors of the first. Consequently, if we multiply the first equation by a function of the $(n-1)^{th}$ degree provided with n indeterminate coefficients, and the second equation by a function of the $(m-1)^{th}$ degree provided with m such coefficients, the resulting functions of the $(m+n-1)^{th}$ degree, each containing $m+n$ terms, must be identical; and by equating the coefficients of their like terms we shall obtain $m+n$ equations, which the $m+n$ introduced constants must satisfy. These equations will obviously be homogeneous and linear; their resultant, therefore, which is manifestly that of the given equations required, is at once obtained in the form of a determinant, as above explained. Another very convenient method for obtaining the resultant of two equations in the form of a determinant was invented by Prof. Sylvester, and called by him the *dialytic method* of elimination. The equations being homogeneous of the m^{th} and n^{th} orders respectively, the first is multiplied, successively, by

$$x^{n-1},\ x^{n-2}y,\ \ldots\ldots\ x\,y^{n-2},\ y^{n-1},$$

and the second by

$$x^{m-1},\ x^{m-2}y,\ \ldots\ldots\ x\,y^{m-2},\ y^{m-1}.$$

The result is a system of $m+n$ equations of the order $m+n-1$, from which the $m+n$ *different powers and products*, such as x^{m+n-1}, x^{m+n-2}, &c., may be eliminated as from a system of linear equations, and the resultant obtained in the form of a determinant. The dialytic method may be extended to the elimination of three variables from three equations of the same order. (*Phil. Mag.* vol. xxi. 1842.)

Bezout's method of elimination leads often to simpler results. The following very concise statement of the method in the case of two equations of the same degree is due to Prof. Cayley. (Crelle's *Journal*, vol. liii. 1857.) If $F(x, y)$ and $f(x, y)$ have a common factor, then the equation

$$F(x\,y)f(x'y') - F(x', y')f(x\,y) = 0$$

can be satisfied whatever values x' and y' may have. A factor of this equation is obviously $xy'-yx'$, and may be divided out. The coefficients of the several powers and products of $x'\,y'$ in the quotient may then be equated to zero, and from the equations thus obtained the powers and products of x and y may be eliminated as in the dialytic method.

Bezout's method, differently enunciated, may be applied also to two equations of different degrees. (Salmon's *Higher Algebra.*) One of the most recent treatises on Elimination is by Faà de Bruno (*Théorie générale de l'Élimination*, Paris 1859). The elements of the subject, however, are given in several treatises on Algebra and the Theory of Equations.

Eliquation or **Liquation** (Lat. eliquatio). The separation of two metals by fusion.

Elision (Lat. elisio). In Grammar, the cutting off or suppressing of a vowel at the end of a word, for the sake of euphony or the measure of the verse. The use of the *elision* was confined chiefly to the languages of Greece and Rome.

Elixir (Arab.). A term applied in old Pharmacy to certain essences or tinctures: a mixture of an aromatic tincture with sulphuric acid was called *elixir of vitriol*. The alchemists applied the term *elixir* to various solutions employed in the art of transmutation.

Elk. [DEER.]

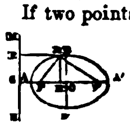
Ell (Dutch eln, Fr. aulne, Lat. ulna, Gr. ὠλένη). A measure of length adopted from the length of the forearm. The English ell is 3 feet 9 inches, and the Flemish 27 inches in length.

Ellagic Acid. An acid obtained by Braconnot from gall nuts, and differing from the gallic acid: the term is derived from the word *galle*, reversed. It is a grey crystalline powder, insoluble in water, but soluble in the alkalies. It is contained in the intestinal concretions known as *Oriental Bezoars*.

Ellipse (Gr. ἔλλειψις, *defect*). One of the conic sections, obtained on cutting a cone by a plane passing obliquely through its opposite sides. [CONIC SECTIONS and QUADRIC.]

We here subjoin one or two properties of the ellipse which lead to methods of describing the curve mechanically.

If two points F and F′ be given in a plane, and a point D be conceived to move around them in such a manner that the sum of the two distances D F and D F′ is always the same, the point D will describe upon the plane an ellipse A D B. The points F and F′ are the *foci* of the ellipse; and the point C, which bisects the distance between the foci, is its *centre*. The line A A′ is the *major* or *transverse axis*; and B B′, which passes through the centre, and is perpendicular to A A′, is the *minor* or *conjugate* axis.



The extremities of the axes are the *vertices*, and the double ordinate at either focus is called the *parameter* or *latus rectum*. If a and b denote the major and minor semi-axes, and p the parameter, the equation of the curve, taking the vertex A as origin, is

$$y^2=px-\frac{b^2}{a^2}\,x^2;$$

that is, the square of the ordinate is less than, or differs in *defect* from, the rectangle under the parameter and abscissa. The term *ellipse* took its origin in this property. Referred to the centre as origin, the equation of the ellipse is

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1.$$

Its polar equation, referred to the focus F as pole, is

$$r=\frac{a(1-e^2)}{1+e\cos\phi},$$

where $e=\frac{\mathrm{CF}}{\mathrm{CA}}$ is the *excentricity*, and $\phi=$ D F H the *anomaly*. Another useful auxiliary angle, which may frequently be employed with advantage in questions connected with the ellipse, is the *excentric angle* θ, which is determined by the relations

$$x=a\cos\theta,\ y=b\sin\theta,$$

where the origin is supposed to be at the centre.

If a moving or generating circle roll along the concave circumference of a fixed circle in the same plane, and the radius of the former be half that of the latter, any given point in the plane of the generating circle, within or without it, will describe an ellipse. This very remarkable property of the ellipse, by which the curve is shown to be a hypotrochoid, has been applied to the construction of instruments for describing an ellipse by continued motion. (Wallace's *Conic Sections*.) [ELLIPTIC COMPASSES.]

The area of the ellipse is expressed by $\pi a b$, where $\pi=3{\cdot}14159$, and its whole periphery by the series

$$2\pi\left(1-\frac{1}{2^2}e^2-\frac{1^2\cdot3}{2^2\cdot4^2}e^4-\frac{1^2\cdot3^2\cdot5}{2^2\cdot4^2\cdot6^2}e^6-\frac{1^2\cdot3^2\cdot5^2\cdot7}{2^2\cdot4^2\cdot6^2\cdot8}e^8\&c.\right)$$

where the major semi-axis is supposed to be unity, and e is the excentricity, which in this case is equal to $\sqrt{1-b^2}$, if b be the minor semi-axis.

Ellipsoid. One of the surfaces of the second order, which is cut by every plane in an ellipse. It is symmetrical with respect to three rectangular axes $2a$, $2b$, $2c$, and has for its equation, referred to these axes,

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}+\frac{z^2}{c^2}=1.$$

Its numerous, remarkable, and very important properties are given in every good treatise on Coordinate Geometry. [QUADRIC.]

Ellipsoid of Revolution, called also **Spheroid.** The surface generated by the rotation of an ellipse around one of its axes. The spheroid is said to be *prolate* or *oblate*, according as the axis of revolution is the major or minor axis of the *ellipse*.

Elliptic Compasses. An instrument for describing an ellipse by continued motion. [ELLIPSE.] Various contrivances for effecting this purpose are described in the *Exercitationes Mathematicæ* of Schooten.

Elliptic Coordinates. [COORDINATES.]

Elliptic Cylinder. A surface generated by a line sliding, parallel to itself, along an ellipse. An elliptic cylinder may be considered as an oblique cylinder on a circular base. [CYLINDER.]

Elliptic Functions. Inverse functions of an elliptic integral. They bear the same relation to the latter as trigonometrical functions do to inverse trigonometrical ones, and exponential functions to logarithmic ones. Thus the amplitude ϕ of an elliptic integral u of the first species [ELLIPTIC INTEGRAL] being regarded as a function of u and of its modulus k, any trigonometrical function of ϕ is termed an

elliptic function, having the *argument* u and *modulus* k. In this point of view, ϕ is usually expressed by the symbol $am.(u,k)$, and the elementary elliptic functions $\sin\phi$, $\cos\phi$ and $\sqrt{1-k^2\sin^2\phi}$ are denoted by the symbols $\sin am.(u,k)$, $\cos am.(u,k)$, and $\Delta am.(u,k)$. The elliptic functions $\tan am.(u,k)$, $\cot am.(u,k)$, $\sec am.(u,k)$ and $\operatorname{cosec} am.(u,k)$ can, of course, be obtained from the first two by mere division. The advantages to be gained by the introduction of elliptic functions into analysis appear to have been first recognised by Abel. They obviously include both trigonometrical and exponential functions. Trigonometrical functions are, as is well known, *periodic*, the *period* or periodic interval being real and equal to 2π. Exponential functions are also periodic, but their period is imaginary, and equal to $2i\pi$, where $i=\sqrt{-1}$. Elliptic functions, as might be at once anticipated, are *doubly periodic*, in the sense of having a *real*, as well as an *imaginary period*.

Elliptic Integrals. It is well known that every integral of an algebraic expression which involves no higher irrationality than the square root of an integral function of the second degree can be expressed in finite form by means of algebraical, inverse trigonometrical, and logarithmic functions. This is no longer the case, however, when, under the radical sign in the expression to be integrated, occurs an algebraic function of the third or fourth degree; the integral is then said to be *elliptic*, since in the rectification of the ellipse such integrals present themselves. If under the radical sign a function of a higher degree than the fourth occurs, the integral is called *hyper-* or *ultra-elliptic*. The most general form, therefore, of an elliptic integral is

$$\int f(x, \mathrm{R})\,dx,$$

where f denotes any rational algebraic function, and

$$\mathrm{R}=\sqrt{a+bx+cx^2+dx^3+ex^4},$$

d and e being coefficients which do not *both* vanish. This integral, however, can always, by suitable substitutions and reductions, be subdivided into others, of which those which are not expressible by algebraic, inverse trigonometrical, or logarithmic functions can be made to assume one of the three following *canonical* forms:—

$$\int_0^\phi \frac{d\phi}{\sqrt{1-k^2\sin^2\phi}},\quad \int_0^\phi d\phi\sqrt{1-k^2\sin^2\phi},$$

and

$$\int_0^\phi \frac{d\phi}{(1+n\sin^2\phi)\sqrt{1-k^2\sin^2\phi}}.$$

Legendre, who first accomplished this reduction, and thus founded the theory of elliptic integrals, called these integrals respectively elliptic integrals of the first, second, and third species, and represented them, respectively, by the symbols

$$\mathrm{F}(\phi,k),\ \mathrm{E}(\phi,k),\ \Pi(\phi,k,n).$$

The quantity k, which is always less than unity, is called the *modulus*, and in the third integral n, which may be real or imaginary, is termed the *parameter*. The best works on the subject are Legendre's *Exercices de Calcul Intégral*, Paris 1811, and *Traité des Fonctions Elliptiques*, Paris 1832; Abel's *Œuvres Complètes*, Christiania 1839; Jacobi's *Fundamenta Nova Theoriæ Functionum Ellipticarum*, Regiomonti 1829; Briot and Bouquet's *Théorie des Fonctions doublement périodiques*, Paris 1859; and Durège's *Theorie der Elliptische Functionen*, Leipzig 1861.

Elliptic Paraboloid. A surface of the second order, whose plane sections are either ellipses or parabolas. [QUADRIC.] Its equation can be reduced to the form

$$z=\frac{x^2}{a}+\frac{y^2}{b},$$

where a and b are positive magnitudes. The coordinate planes here coincide with the *principal* planes of the surface, the origin being at its vertex. All planes through the z axis cut the surface in parabolas; all planes perpendicular to that axis either cut the surface in ellipses or do not meet it at all. When $a=b$ the surface becomes a *paraboloid of revolution*, generated by the rotation of a parabola around its principal diameter or axis.

Elliptic Point. A point on a surface at which the indicatrix is an ellipse. Such a point is always a *conjugate* point of the curve in which the tangent plane intersects the surface; that is to say, the tangents to the section through this point (inflexional tangents of the surface) are always imaginary. [INDICATRIX.]

Elliptic Polarisation. [POLARISATION OF LIGHT.]

Ellipticity of the Terrestrial Spheroid. A term used by Clairaut, and other writers on the figure of the earth, to denote the deviation of the earth's form from that of a sphere. Clairaut employed the term to denote the difference of the two axes divided by the smaller: most writers understand by it the difference of the axes divided by the greater. Thus, let a be the equatorial diameter, b the polar diameter, e the ellipticity; then $e=\frac{a-b}{a}$, whence $b=a(1-e)$.

Elm (Lat. ulmus; Dutch, olm). A valuable genus of trees, confined to the colder parts of the northern hemisphere, but common to both the Old and New World. Most of the species are trees of considerable size, and produce a timber useful for many common purposes in which great strength and durability are not required; but some of them are small bushes of no known value. In Great Britain there are several species in a wild state, the most valuable of which are called the *Welsh*, the *Hertfordshire*, the *Huntingdon*, and the *smooth-leaved*; in other countries of Europe and Asia many peculiar species exist. The Elm is valued for the rapidity of its growth, its hardiness, and its capability of thriving in poor soil unfit for tillage.

Elmo, Fire of St. A name given to the meteor known as CASTOR AND POLLUX.

Elocution (Lat. elocutio). Signified originally the art of choosing and adapting words and sentences to the ideas to be expressed; but it is more frequently employed to denote the right management of the voice, countenance, and gesture in speaking; in which sense it is synonymous with what is termed a *good delivery* or *pronunciation*. [DECLAMATION; ELOQUENCE.]

Éloge. A term applied in France to the panegyrical orations pronounced in honour of illustrious deceased persons, and particularly of members of the Royal and other academies. Formerly the secretaries of the various French literary institutions used to compose and pronounce the *éloge*; but this duty is now performed by the new member elected in the room of the deceased.

Elongation (Lat. e, and longus, *long*). In Astronomy, the apparent angular distance of a planet from the sun. The greatest elongation of Mercury amounts to about 28½°, and that of Venus to about 47° 48′. With regard to the superior planets, the elongation may have any value from 0 to 180°.

Eloquence (Lat. eloquentia). The art of clothing the thoughts in the most suitable expressions, in order to produce conviction or persuasion. In its primary signification, eloquence (as indeed its etymology implies) had reference to public speaking alone; but as most of the rules for public speaking are applicable equally to writing, an extension of the term naturally took place. The influence exercised by speakers in the Homeric poems, is sufficient evidence of the enormous interval which separated the Achæans (of a time long preceding the rise of contemporary history) from the immovable intellect of the Asiatic. Nestor and Odysseus could not be valued by a people incapable of governing themselves. But though, from time to time, there arose in Greece many distinguished writers upon eloquence, it does not appear that the practice of the art was systematically combined with the theory for public purposes till the time of Pericles, who was distinguished at once as a general, a statesman, and an orator. In the succeeding age arose the school of rhetoricians, or sophists, as they are called, who endeavoured to graft upon eloquence the subtleties of logic. (Grote's *History of Greece*, part ii. ch. xlvi.) Among the earliest and most eminent of this school were Gorgias, Isocrates, and Isæus, of whose publicly delivered orations ten are still extant. It was in this age that Grecian eloquence attained its highest perfection by the genius of Demosthenes. After this period, it declined rapidly; and though in the following ages there flourished among others Hermagoras, Athenæus, Apollonius, Cæcilius, and Dionysius, their names have been almost without exception rescued from oblivion by a work which may be regarded as the last expiring ray of Grecian eloquence—the treatise of Longinus on the Sublime.

At Rome, even so late as the year of the city 592, when, by the industry of some Greeks, the liberal arts began to flourish there, the senate passed a decree banishing all rhetoricians from the country. But a few years afterwards, when Carneades, Critolaus, and Diogenes were sent as ambassadors from Athens to Rome, the Roman youth were so charmed with the eloquence of their harangues, that the study of oratory formed thenceforth a branch of a liberal education. Men of the highest rank were now seen teaching and learning the art of eloquence; and such was the impetus given to this study, that it made the most rapid advances, and was at last crowned by the appearance of Cicero. That many illustrious orators existed at Rome prior to the age of Augustus, we learn from the work of Cicero, *De Claris Oratoribus*. In the succeeding ages of the Roman empire, the despotic character of the government checked the growth of the rhetorical art; but the names of Tacitus, Quintilian, and Pliny are an earnest of what might have been achieved had circumstances permitted the developement of their talents.

During the middle ages, the theory of eloquence formed part of the scholastic study, as may be seen from the old doggrel hexameter, which served to fix the monastic studies in the memory—

> 'Gramm. (Grammatice) loquitur; Dia. (Dialectice) vera docet; Rhet. (Rhetorice) verba colorat.'

The history of eloquence in our own country brings before us the names of many great men who in former times directed the resolutions of our parliament; but no pains were taken to preserve their speeches. The orations of Chatham, Pitt, Burke, Fox, and Sheridan have experienced a better fortune; but the power of words has been felt in every stage of English history, as it can only be felt in countries which are constitutionally free or struggling towards freedom.

The little opportunity afforded for a display of forensic or senatorial eloquence by the different governments of Germany has almost entirely checked its growth in that country; and the same remark is applicable to Italy, Spain, and Portugal; all of which, however, have been rich in the eloquence of the pulpit. The only two countries in the world whose orators can be put in competition with those of Britain, are France and America. To the pulpit oratory of the former, the illustrious names of Bossuet, Bourdaloue, and Massillon have given enduring celebrity; while the popular character of their respective institutions has formed a host of forensic and senatorial speakers worthy a prominent place among the orators of ancient and modern times.

The elements of eloquence are usually comprised under the four following divisions: *invention*, *disposition*, *elocution*, and *delivery*. The first has reference to the character of the thoughts or ideas to be employed; the second, to their arrangement, usually called the *parts* of a discourse, consisting of the EXORDIUM or

INTRODUCTION, the NARRATION, the PROPOSITION, PROOF or REFUTATION, and the PERORATION [see these terms]; and the third and fourth have respect to words, style, utterance, action, &c.

The Greeks divided discourses according to their contents, as relating to precept (λόγοι), manners (ἤθη), and feelings (πάθη). The Romans distinguished three kinds of eloquence, the *demonstrative*, occupied with praise or blame, and addressed to the judgment; the *deliberative*, which acts upon the will by persuasion or dissuasion; and the *judicial* or *forensic*, which was used in defending or attacking—a division originally laid down by Aristotle, *De Rhetorica*. In our own times, a division somewhat similar has been made; and the bar, the senate, and the pulpit are the three grand theatres for the exhibition of oratory.

It is not unfrequently urged that, in modern times, eloquence has not been invested with so much importance, or cultivated with so much care, as among the ancients. For the cause of this alleged inferiority of modern eloquence, no satisfactory reason has been hitherto assigned, and even Hume has confessed his inability to solve the problem. It is important, however, to mark the difference in the means employed in ancient and modern times to gain the consent of the audience. In the former, the most violent and passionate expressions, accompanied by what Cicero calls the *supplosio pedis*, and the *percussio frontis vel femoris*, were not only admissible, but were even necessary, in order to produce an effect upon the audience. At the present day, such violence of gesture, except on the stage, would excite nothing but laughter; and the fact that those orators are now more esteemed who aim at convincing the understanding than at captivating the feelings, must greatly modify the character and style of national oratory. (For the causes which specially stimulated the growth of rhetorical science at Athens, see Grote's *History of Greece*, part ii. ch. xlvi.)

Elutriation (Lat. elutrio, *I cleanse*). The separation of substances by washing them in large quantities of water, so that the heavier particles fall to the bottom, and the lighter ones, remaining some time suspended, are gradually deposited in a finely divided state.

Elvan. In Mining, a Cornish name for certain veins or dykes of porphyritic rock often crossing the direction of metalliferous veins, and interfering with them.

Elymus (Gr. ἔλυμος, *a sheath*). This genus of grasses furnishes one of the plants, *E. arenarius*, which are useful for binding together the loose sandy parts of the coast, which it does by means of its long creeping roots. It is otherwise of little importance, being extremely coarse in its herbage.

Elysium or the **Elysian Fields** (Gr. ἠλύσιον πέδιον). In Mythology, the region to which the souls of the virtuous were said by the poets to be transported after death. They are variously represented as part of Hades, or islands situated in the Western Ocean beyond the Columns of Hercules. The enjoyments of the blessed spirits in this abode were held to consist in the same pursuits that were their delight on earth, carried on in a calmer and happier climate. (*Odyss.* iv. 563; Pindar, *Ol.* ii. 120.)

Elytrum (Gr. ἔλυτρον, *a sheath*). The superior or first pair of wings in four-winged insects are so called, when they are of a coriaceous and hardly flexible texture, and serve as a protective covering to the second pair; as in beetles.

Elzevir Editions. In Bibliography, the name of the works printed and published by the family of Elzevir (properly Elzevier), at Amsterdam, Leyden, the Hague, and Utrecht. The Elzevir editions are valued for their neatness, and for the elegant small types used. The Greek New Testament, the works of Virgil, and those of Terence, are considered their masterpieces, but the Virgil has been found incorrect in some places.

The first Elzevir edition known is Eutropius, published at Leyden by Louis Elzevir, in 1592. His eldest son, Matthew, died at Leyden, in 1640; and his second son, Giles, was a bookseller at the Hague in 1599. The first printer of the name was Isaac, eldest son of Matthew. His works date from 1617 to 1628. Matthew's third and fourth sons, Abraham and Bonaventure, were printers at Leyden from 1618 to 1626. Another brother, Jacob, was a printer at the Hague in 1626. For an account of the subsequent members of the family and of the editions issued by them, see the *Notice de la Collection d'Auteurs Latins, Français et Italiens, imprimée de format petit in 12mo, par les Elzevirs*; Brunet's *Manuel du Libraire*, 3rd edit. 8vo. Paris 1820, vol. iv. pp. 533–537; and the *Essai Bibliographique sur les Éditions des Elzevirs, précédé d'une Notice sur ces Imprimeurs célèbres*, 8vo. Didot, Paris 1822.

Emanant (Lat. emanans, part. of emanare, *to flow out*). The result of operating upon any quantic $(*)(x, y, z \ldots)^n$ with the symbol

$$\left(x'\frac{d}{dx} + y'\frac{d}{dy} + z'\frac{d}{dz} + \&c. \ldots\right)^p,$$

where x', y', z', &c. ... and $x, y, z \ldots$ are cogredient facients, is called the p^{th} *emanant* of that quantic. Every such emanant is a covariant (usually in two sets of cogredient facients) of the original quantic. Every invariant of the emanant, formed by considering the facients $x, y, z \ldots$ as constants, is a covariant of the original quantic. Thus the second emanant of any binary quantic u being

$$x'^2\frac{d^2u}{dx^2} + 2x'y'\frac{du}{dx}\frac{du}{dy} + y'^2\frac{d^2u}{dy^2},$$

we have, on considering it as a function of x', y', the invariant

$$\frac{d^2u}{dx^2}\cdot\frac{d^2u}{dy^2} - \left(\frac{d^2u}{dx\,dy}\right)^2,$$

which is a covariant of u, in fact its Hessian. [HESSIAN.] In geometrical applications the emanants of a quantic represent the several polar curves or surfaces of a given point. [POLES and POLARS.]

Emanation, System of. In Philosophy, a synonym for PANTHEISM [which see].

Emancipation (Lat. emancipatio, from mancipo, *I sell*, or deliver over the tangible property in anything). By the ancient Roman law, the son stood in the relation of a slave to the father. By a fiction of that law, the son might be freed from this relation by being three times sold (mancipatus) by the father. Hence the enfranchisement of the son derived from this ceremony the name of *emancipation*. In course of time, various modes of emancipation, both tacit and express, became recognised by the Roman jurisprudence. The word, in countries following that law, signifies the exemption of the son from the power of the father, either by express act, or by implication of law. By the present civil law of France, majority (and with it emancipation) is attained at twenty-one years of age; and the marriage of a minor emancipates him. (*Code Civil*, lib. 1. c. iii.) In ordinary language, emancipation is used in a general sense to signify the enfranchisement of a slave, or the admission of particular classes to the enjoyment of civil rights.

Emarginate (Lat. emarginare, *to take away the edge*). In Zoology, when the margin of a part is broken by an obtuse notch, or the segment of a circle.

Emarginula. A subgenus of Gastropodous Molluscs, dismembered from the genus *Patella* of Linnæus, and characterised by a shell of a simple conical form, but having a narrow fissure extending from the margin to near the summit.

Embalming (Lat. balsamum, *balm*). A process adopted by the ancient Egyptians, chiefly for the preservation of dead bodies from putrefaction. The term is derived from the use of balsamic substances in the operation; in addition to these, saline substances and tanning materials seem also to have been used. [MUMMY.]

Embankment. A raised mound of earth, for the purpose of carrying a roadway, for forming a barrier of defence against a sea or a river, or for the purposes of a pier or quay. The methods adopted for each of these purposes must, of course, differ with the materials of which they are made, and they will be regulated by the local considerations which every engineer will know how to provide for. The main conditions of embankments are that the slopes should be such as should be permanent; that the weight of the bank should not be such as to force out the foot or toe; and that there should be no tendency in the surrounding ground to displace the bank. The materials must, in fact, be placed according to their angle of repose, or that angle at which they would begin to move if abandoned to themselves. Clay lands, for instance, are liable to slip in bank, if the materials are dressed to an angle of more than 26°, whilst gravel or hard stone may be laid at 34°. Regularly coursed stone may be laid at a much larger angle. The description of bank will also regulate the slope to some extent, for should it be required to resist the pressure of water on one side, it is found that the slope towards the water had better be 34°, and that towards the open country 26°, with a considerable thickness at the crown. The tendency of the subsoil of an embankment to compress under the effects of the load brought upon it may be resisted by widening the base, by stepping the foundations, and by filling the core or the heart of the embankment with some light and bulky materials. The best remedy for this inconvenience is, however, to isolate the foundation by a system of piling.

Great care must be taken to get rid of any water that may filter through the materials or the seating of an embankment, and the drains must be so provided that all danger of ravinement shall be avoided. If possible, the earthwork should be carried up in layers, and the earth rammed, to insure the equal compression of the materials; but executed as the railway banks are at the present day, it is hardly possible to obtain this perfection of execution. A useful precaution consists in dressing the slopes and covering them with vegetable soil, which would allow of their being turfed; this of course cannot be done when the bank is formed of gravel, or of some descriptions of stones.

The largest embankments of modern times are the Tring cutting of the North-Western Railway, which contains one million and a half yards; the Gadelbach cutting, of one million and three-quarters, on the Ulm and Augsburg Railway; and the Oberhäuser embankment, on the Augsburg and Lindau line, which contains as much as two millions and a half yards cube.

At the present day much attention has been directed to the nature of embankments, by the accidents that have occurred to the reservoirs of Holmfirth and Bradfield (Sheffield), by the failure of the enclosure of the Fenlands in the neighbourhood of King's Lynn, and also in consequence of the great operations undertaken by the Metropolitan Board of Works for the reclamation of the waste lands on the banks of the river Thames. [QUAY WALLS; RESERVOIRS; RIVER BANKS.]

Embargo (Span.). A restraint or prohibition imposed by the public authorities of a country on merchant vessels or other ships, to prevent their leaving its ports. Embargoes are usually imposed only in time of war, or in apprehension of an invasion; in which cases the government employs the ships under embargo in armaments, expeditions, and transportation of troops, &c. When it is found necessary to stop the communication of intelligence between any two places, an embargo is laid upon all ships, both foreign and under the national flag.

Embassy. [AMBASSADOR.]

Embelia (the Cingalese name). A common Indian species of this genus of *Myrsinaceæ*, *E. Ribes*, yields berries, which are sold to traders for the adulteration of black pepper, which they resemble, having moreover a slight pungency. They are anthelmintic.

Ember Days. In the church calendar, certain fast days first appointed by Pope Calixtus, A.D. 220, for imploring a blessing on the fruits of the earth, and on the ordinations performed at these times. They occur four times a year, being the Wednesday, Friday, and Saturday after the first Sunday in Lent, after the Feast of Pentecost or Whitsunday, after the festival of Holy Cross on the fourteenth of September, and after the festival of St. Lucia on the thirteenth of December. The weeks in which the ember days fall are called *ember weeks*. The term is by some connected with A.-Sax. æmyrian, Dan. emmer, in the sense of *ashes*, which the primitive Christians strewed on their heads at these solemn fasts; but the forms *quatember*, Dutch *temper*, Swed. *tamperdagar*, *ymber-dagar*, show the process of corruption from the Latin words quatuor tempora, *the four seasons*.

Emberiza. The name of a genus of Passerine birds, characterised by having the upper mandible narrower than the under one, with the edges turned inwards, and with a hard knob on the palate: the entire bill has the usual short strong conformation of the *Conirostral* tribe of Passerine birds. It is now the type of a family, subdivided into minor genera, under the name of *Emberizidæ* or Buntings.

Embezzlement (perhaps from the obsolete verb bezzle, *to swallow* or *waste in riot*). In Law, a felony, consisting of the same class of acts which would in any other case amount to larceny, when committed by one employed as a clerk or servant, and by virtue of his office, on the goods and chattels of his employer.

Emblazoning. [HERALDRY.]

Emblem (Gr. ἔμβλημα, literally *something inserted*). This term has various significations; but it is used most frequently in English to signify a figurative representation, which by the power of association suggests to the mind some idea not expressed to the senses. In Bibliography, books consisting of a series of plates, containing emblematic subjects, with explanations, generally in verse, in Latin or modern languages, are termed *books of emblems*. They were fashionable in the latter half of the sixteenth century. The best known are the *Emblemata Alciati*, by André Alciat, a French lawyer, and the emblematic Poems of Jacob Cats.

Emblica (the native Moluccan name). One of the genera of *Euphorbiaceæ*, *E. officinalis*, formerly called *Phyllanthus Emblica*, is a moderate-sized tree grown in India and in the Archipelago, for its bark, which is used in tanning and to dye cotton black; for its fruits, which are used as a pickle, and though extremely acid are also made into sweetmeats; and for its wood, which is hard and valuable, and resists damp well. The plant also possesses some medical properties.

Embolismic (Gr. ἐμβολισμός, *an intercalation*). In Chronology, a term synonymous with *intercalary*, and applied chiefly to the additional months required to fill up the lunar cycle. [CYCLE and EPACT.]

Embossing, Embossment (Fr. bosse, *a protuberance*). In Architecture and Sculpture, the raising or forming in rilievo any sort of figure, whether performed with a chisel or otherwise. It is a kind of sculpture, in which the figures rise from the plane on which they are formed; and as they are more or less prominent, they are said to be in alto, mezzo, or basso rilievo, or in high, middle, or low relief.

Embouchure (Fr.). Signifies the mouth of a river; it is used also for the mouthpiece of a musical instrument.

Embracery (Nor. Fr. embraserie). In Law, the offence of endeavouring to corrupt or influence a jury; punishable by fine and imprisonment.

Embrasure (Fr.). In Fortification, an opening made in the parapet of a fortified place, or breastwork of a battery, through which the guns are fired. The embrasures are usually made about two feet wide at the interior extremity or neck, and half as thick as the parapet at the exterior crest, while the sole or lower surface is at the height of about 2½ feet above the platform on which the carriage of the gun is placed; but their forms and dimensions are, of course, varied according to their position with regard to the point against which the fire is to be directed, and the kind of piece to be fired through them.

Embrocation (Gr. ἐμβρέχω, *I foment*). A fluid application to any part of the body when painful or inflamed.

Embroidery (Fr. broderie). The name given to the art of working figures on stuffs or muslin with a needle and thread. All embroidery may be divided into two sorts, embroidery on *stuffs* and on *muslin*: the former is used chiefly in church vestments, housings, standards, articles of furniture, &c., and is executed with silk, cotton, wool, gold and silver threads, and sometimes ornamented with spangles, real or mock pearls, precious or imitation stones, &c.; the latter is employed mostly in articles of female apparel, as caps, collars, &c., and is performed only with cotton. In Germany this division is indicated by the expression *weisse* (*white* or muslin), and *bunte Stickerei* (*coloured* or cloth) *embroidery*. The embroidery of *stuffs* is performed on a kind of loom or frame; that of *muslin* by stretching it on a pattern already designed. The modes of embroidering stuffs or muslin with the common needle are very various; but they consist for the most part of a combination of ordinary *stitches*. The art of embroidery was well known to the ancients. Long before the Homeric age the women of Sidon had acquired celebrity for their skill in embroidery. At a later period, this art was introduced into

Greece; and to such a degree of skill did the Grecian women attain in it, that their performances were said to rival the finest paintings. In our own times the art of embroidery has been cultivated with great success, more especially in Germany and France; and though for a long period it was practised only by the ladies of these countries as an elegant accomplishment, it is now regarded as a staple of traffic, and furnishes employment for a large portion of the population. A great impetus has been given to the cultivation of this art, both on the Continent and in England, by the invention of a machine which enables a female to execute the most complex patterns with 130 needles, all in motion at once, as accurately as she could formerly do with one. But as no account of this remarkable invention which we might give could be intelligible without the aid of illustrations which would be out of place in this work, we must refer the reader to Dr. Ure's *Dictionary of Arts*, &c. for full information respecting it. One such machine with 130 needles is estimated to perform daily the work of fifteen hand embroiderers employed in the ordinary way. Many of them are now mounted in Germany, France, and Switzerland; and in Manchester there is one factory where they do beautiful work. (*Art of Needlework*, edited by the countess of Wilton, London 1840.)

Embryo (Gr. ἔμβρυον, from βρύω, *I bud forth*). In Botany, a fleshy body seated in the interior of the seed, and constituting the rudiment of the future plant. It is divided into three parts: a *plumule* or growing point, a *radicle* or root, and a *cotyledon* or *cotyledons*. It is the vegetable fœtus; and is so tenacious of life under particular circumstances, that there are well-attested instances of its having preserved its vitality much beyond 1,000 years.

The term is also applied to the fœtus in utero before the fifth month of pregnancy.

Embryotomy (Gr. ἐμβρυοτομία). The operation of cutting the fœtus out of the womb.

Emerald (Fr. émeraude), A mineral occurring in green six-sided prisms, and much valued as a gem. It is a silicate of alumina and glucina. The colour is due to oxide of chromium. The most celebrated modern locality of the emerald is Muzo, in New Grenada, where it is found in a limestone containing ammonites; emeralds are also found in Peru, at Cundina-Marco in Old Columbia, Canjargum in Hindustan, and in the Henbach Valley, Salzburg. The mines from which the ancients obtained their emeralds are said to have been situated near Mount Zabarah, in Upper Egypt.

Emerald. In Printing, a kind of type one size and a half smaller than that used in this work. [Type.]

Emeriti (Lat.). The name given to Roman soldiers who had fulfilled the legal term of military service.

Emersion (Lat. emergo, *I rise*). In Astronomy, the reappearance of the sun, moon, or planets, or of a star, from behind the celestial body by which it has been eclipsed. The phenomena of *immersions* and emersions are of considerable use in determining the longitudes of places.

Emery (from Cape *Emeri*, in the island of Naxos). An amorphous form of Corundum. It occurs massive, granular and compact, and is generally opaque. It consists of alumina frequently rendered impure by oxide of iron and silica. It is characterised by excessive hardness, and its powder is used in cutting and polishing glass, gems, steel, and other metals. The greater part of the emery used in this country is obtained from the isle of Naxos in the Grecian Archipelago. [Corundum.]

Emetics (Gr. ἐμετικός, *provoking sickness*). Medicines which occasion vomiting. The only vegetable emetic in general use is *ipecacuanha*, from ten to twenty grains of which is a dose; the chief mineral emetics are the *tartrate of antimony and potash*, or *emetic tartar*, *sulphate of zinc*, and *sulphate of copper*. When it is merely wished to evacuate the contents of the stomach in cases where it is disordered by improper food, twenty grains of ipecacuanha in an ounce of water is a safe and good emetic; it generally operates in from ten to twenty minutes, and its action may be assisted by chamomile tea or warm water. At the beginning of fevers or inflammatory disorders, an emetic is often advantageously administered, and then ten or fifteen grains of ipecacuanha with half a grain or a grain of emetic tartar in an ounce and a half of water is to be preferred: the perspiration which the vomit induces should be kept up by remaining in bed, and by warm drinks or other proper remedies. Where poisons have been swallowed, the stomach is often insensible to these means, especially where large doses of opium are concerned; and then half a drachm of sulphate of zinc or of sulphate of copper may be dissolved in three ounces of warm water, and a third part of the solution taken every ten minutes till it operates. In such cases, however, the stomach-pump is principally to be relied upon. When emetics are given in small doses, they produce *nausea*, and to this extent they have proved useful in restraining hæmorrhage of the stomach and lungs. Emetics should be avoided in all plethoric habits, and where there are any symptoms announcing fulness of the vessels of the head; in hernia, in the advanced stage of pregnancy, and in active inflammations. They should also be given with the utmost caution to young children; and when given, ipecacuanha should be resorted to. Old chronic pains and obstinate rheumatism are sometimes relieved by an emetic.

Emetic Tartar. A triple salt, composed of oxide of antimony, potassa, and tartaric acid. It is soluble in eighteen parts of cold and in three of boiling water. In the dose of from half a grain to two grains it operates as a powerful emetic and sudorific; in smaller doses, it acts upon the bowels, and is diaphoretic.

Emetic tartar is also a powerful local irri-

tant, and when applied in the form of ointment, or lotion, it produces a pustular eruption.

In excessive doses (twenty to forty grains), it acts as an acrid poison, and is liable, even in small doses, to poison young children. In cases of accidental poisoning by this salt, vomiting must be promoted by the use of warm water mixed with butter, oil, or grease, and by the administration of strong green tea, infusion of oak bark, or other forms of *tannin*, which, by decomposing the salt, act as direct antidotes, inasmuch as *tannate* of antimony seems to be nearly inert.

Emetine. A substance discovered in 1817 by Pelletier in ipecacuanha. It is white, pulverulent, and bitter; easily soluble in hot water and alcohol, and intensely emetic. It exists in ipecacuanha to the amount of about 16 per cent., and appears to be the sole cause of its emetic property.

Emigration (Lat. emigratio). *To migrate* is to move from one place to another, and the character of the migration was determined in Latin by the preposition denoting the direction taken. Hence *demigrare* is to change one's house in the same locality or city, *emigrare* is to quit the city, *immigrare* is to enter it.

The practical significance of emigration, in its modern sense, is twofold: first, by its relieving a country of its surplus population; next, by its extending and enlarging the field over which civilisation may be induced, and indirectly by its developing the characteristics of a particular race. The former of these ends is wholly economical; the latter is relative to the history of civilisation, and the political capacities and energies of some races of mankind as contrasted with others.

It is quite clear, unless some checks, natural and voluntary, are put upon population, that the increase of numbers would soon outrun the means of subsistence. Among these voluntary checks, one of the most notable is that which prompts men to seek their fortunes in some less densely occupied portion of the earth's surface. It is well known that Europe has been twice or thrice peopled by different races; and in almost every case, the migration of tribes has been prompted by the pressure which population has put upon the means of living. This compulsory emigration was symbolised in Roman history under the name of *ver sacrum*; the persons born in the year in which the vow known by this formula was taken, being constrained to emigrate when they reached adolescence. Similarly, in the ancient Greek communities, where the limits of population were rapidly reached, the practice of emigration was constant, and the process was surrounded by specified solemnities.

It does not appear that countries from which emigration proceeds rapidly, suffer, except under particular circumstances, any great decrease in their population. As long, indeed, as a country is in a state of economical progress, and therefore capital is rapidly accumulated and beneficially employed, the same area will suffice to maintain an increasing number of inhabitants, and emigration will not in general be so considerable a relief to population, as it is the resort of energetic and active individuals. At all times, any attempt to check the disposition towards emigration arises from a misconception of the province of government, and ends in increasing discontent among those whose action is hindered or prevented.

The region to which emigration proceeds most rapidly is the countries occupied by the United States. The passage is easy and comparatively short, the amount of land naturally clear is great, and the wages of labour as well as the profits of capital are generally high. How far the disposition to proceed to these parts of the world may be checked by recent events, it is not, perhaps, possible to predict; but the subjoined table will show that no great discouragement has been felt as yet.

The extension of the English race, with its language and literature, is a phenomenon of the highest interest to ourselves. The time cannot be far distant when our language will be spoken over the largest part of the civilised world, and our race occupy the most temperate regions of the globe. It bids fair to settle the greater part of the North American continent, and to colonise the largest and most fertile islands in Australasia.

Emigration to the British colonies is considerably aided by a practice suggested in the first instance by Mr. Gibbon Wakefield, of devoting the produce of public land sales to the fund for assisting emigrants.

The following table shows the number and destination of the emigrants who have left the United Kingdom from 1839 to 1864 inclusive:—

Years	North American Colonies	United States	Australian Colonies and New Zealand	All other Places	Total
1839	12,658	33,536	15,786	227	62,207
1840	32,293	40,642	15,850	1,558	90,743
1841	38,164	45,017	32,625	2,786	118,592
1842	38,123	63,852	8,534	1,835	128,314
1843	23,518	28,335	3,478	1,881	57,212
1844	22,924	43,660	2,229	1,873	70,686
1845	31,803	58,538	830	2,330	93,501
1846	43,439	82,239	2,347	1,826	129,851
1847	109,680	142,154	4,949	1,487	258,270
1848	31,065	188,233	23,904	4,887	248,089
1849	41,367	219,450	32,191	6,490	299,498
1850	32,961	223,078	16,037	8,773	280,849
1851	42,605	267,357	21,532	4,472	335,966
1852	32,873	244,261	87,881	3,749	368,764
1853	34,522	230,885	61,401	3,129	329,937
1854	43,761	193,065	83,237	3,366	323,429
1855	17,966	103,414	52,309	3,118	176,807
1856	16,378	111,837	44,584	3,755	176,554
1857	21,001	126,905	61,248	3,721	212,875
1858	9,704	59,716	39,295	5,257	113,972
1859	6,689	70,303	31,013	12,427	120,432
1860	9,786	87,500	24,302	6,881	128,469
1861	12,707	49,764	23,738	5,561	91,770
1862	15,522	58,706	41,843	5,143	121,214
1863	18,083	146,813	53,054	5,808	223,758
1864	12,721	147,042	40,942	8,195	208,900

Eminence (Lat. eminentia). A title of honour borne in Europe by various dignitaries at different times; but appropriated to cardinals by a papal decree of the year 1630.

Eminentia Collateralis (Lat.). This name has been given by Anthropotomists to the prominence which extends transversely across the spot where the *hippocampi major and minor* unite in the lateral ventricle of the human brain. It has also been termed *eminentia lateralis s. Meckelii.*

Emir (Arab. *chief* or *lord*). The khalifs took the title of *Emir-al-Mumenin*—chief or commander of the faithful. The title is now given by prescriptive usage to those who are considered to descend from Mohammed, by his son-in-law Ali and his daughter Fatima. [Scherif.] But when joined to another word expressive of a particular command or office, it is a common title of dignity; as *Emir-al-Omrah*—a title given by the Turks to viziers and pachas, &c. [Mirza.]

Emmenagogue (Gr. ἐμμήνιος, *monthly*, and ἄγω, *I move*). Medicines which promote the menstrual evacuation.

Emollients (Lat. emollio, *I soften*). Medicines which are supposed to relax the living animal fibre, and are directly opposed to *tonics*.

Empalement (Lat. in, and palus, *a stake*). A cruel punishment, which consisted in thrusting a stake into the body of the victim, and then leaving him to perish. It was frequently practised by the ancient Romans, and more recently by the Turks and other barbarous nations.

Emperor (Lat. imperator). The title *imperator* was conferred by the Romans on their consuls, in their military capacity, after this authority had been confirmed to them by the comitia curiata. On the fall of the republic, it was conferred, first for a definite period and afterwards for life, on Augustus. The authority of the Roman emperors was formed principally by the combination of the chief offices of the old republic in a single person; besides which, some extraordinary powers were conferred. Thus, Octavius held the titles of imperator, proconsul, tribune, and pontifex maximus or high priest; and was invested with perpetual consular authority, and also with that of the censorship. Besides this, he was termed *prince of the senate*, and *Augustus*, which designation descended to his successors; but he was much more moderate in his use of titular dignities than his successors, contenting himself with substantial power. The provinces of the empire were divided between the senate and emperor, who appointed their governors, distinguished by the respective titles of *proconsul* and *proprætor*; but this division threw all the armies into the hands of the latter, as he took for his share the frontier provinces. The emperors appointed their own successors, who were dignified with the title of *Cæsar*, and in later times enjoyed a share in the government. Diocletian first divided the care of the empire with a second Augustus in the person of Maximian, and each of these colleagues associated with himself a Cæsar. After the court was removed to Constantinople, the old titles and forms of the republic vanished by degrees, and the emperors assumed the style of Oriental princes. [Cæsar.]

The title of emperor of the Romans, with that of Augustus, was conferred in 800 by Pope Leo III. on Charlemagne, by whose successors it was held until the dissolution of the Holy Roman Empire in 1805. The imperial style has since been assumed by the archdukes of Austria, by the Bonapartes in France, and by the czars of Russia.

Empetraceæ (Empetrum, one of the genera). A small order of monochlamydeous Exogens, of the Euphorbial alliance. They are diclinous heath-like plants, with small axillary flowers and fleshy fruit. The fruit of *Empetrum nigrum*, the Black Crowberry, is sometimes eaten, and a fermented liquor is also prepared from it.

Emphasis (Gr. ἔμφασις). In Elocution, the stress laid on particular words or syllables in a sentence, in order to express or enforce a meaning.

Emphasis. In Music. [Accent.]

Emphysema (Gr. ἐμφύσημα, *an inflation*). A diseased condition of lung generally consequent on chronic bronchitis, consisting in dilatation of the air-cells and occasional rupture of two or more into one. Another and rarer form is caused by escape of air from the lung by rupture, when air-bubbles are found under the pleura or covering membrane of the lung.

Emphyteusis (Gr. ἐμφυτεύω, *I plant*). In the Civil Law, a contract by which houses or lands are given to be possessed for ever, or for a long term, and an annual rent or pension (*canon emphyteuticus*), either in money, grain, or any other thing, reserved and made payable to the grantor as a recognition of his paramount title. The grantor is said to retain the *dominium directum*, the grantee to acquire the *dominium utile* or *usufruct*. The Scottish grant in feu-farm resembles the emphyteusis. From this word (pronounced in the lower age of Latinity, emphytefsis) it is supposed that fief (fevodum, feodum) is derived.

Empire (Lat. imperium, the power conferred by the state on those who were appointed to command the army). The dominions under the sway of the Roman emperors were the first to which the term *empire* was applied: they consisted of two grand divisions, the Empire of the East, or, as it was afterwards called, the Lower Empire; and the Empire of the West. The latter became, about the end of the ninth century, the Holy Roman Empire. (Bryce, *Holy Roman Empire.*) But the term *empire* has in several instances been employed to designate *a large extent of dominion*, without reference to the title of the ruler or sovereign of a country: thus we hear of the empire of Persia, Hindustan, &c. The dominions of the queen of England are invariably designated the British Empire; and the epithet *imperial* is officially prefixed to the parliament of the United Kingdom.

Empiric (Gr. ἐμπειρικός). One whose knowledge is founded on experience. The empiric school of medicine was opposed to the

dogmatic; it appears to have originated with Serapion of Alexandria. The empirics considered the foundation of medical science to rest upon experience, derived either directly from experiment or from chance and imitation. They were, however, a pretentious and generally ignorant sect; so that the term *empiric* is generally applied to quacks and pretenders, without reference to its strict etymology, which should have limited it to the study of medicine, in accordance with the principles of Lord Bacon's philosophy.

Emplastics (Gr. ἐμπλαστικός, *clogging*). Medicines which have a tendency to cause constipation and shut up the pores of the body.

Emporium (Gr. ἐμπόριον). A city or place where great commercial transactions are made. The word has been in use in England for more than three centuries.

Emprosthotonos (Gr.). A spasmodic action of the muscles, by which the body is involuntarily drawn forwards. [TETANUS.]

Empyema (Gr. ἐμπύημα, *suppuration*). A collection of purulent matter in the cavity of the thorax. This is an occasional termination of pleurisy, and is attended by difficulty of breathing and inability to lie on the side opposite that which is affected; an external swelling is sometimes perceptible, and the matter has occasionally been let out by making an opening between the sixth and seventh ribs.

Empyreal Air. Oxygen gas.

Empyreuma (Gr. ἐμπύρευμα, from ἐμπυρεύω, *I kindle*). A burnt odour. Hence the oils obtained by distilling various organic substances at high temperatures are called *empyreumatic oils*.

Emu. A three-toed Struthious bird, peculiar to Australia, differing from the rhea of South America in the extreme shortness of its wings, and from the cassowary of Java in the absence of the horny projection on the head.

Emulgent (Lat. emulgeo, *to milk out*). The artery and vein which go from the aorta and vena cava of the kidney are so called, from the ancient notion of the blood being, as it were, strained in the kidneys.

Emulsin. [SYNAPTASE.]

Emulsion (Lat. emulgeo, *I milk*). A milky liquid; as *almond emulsion*.

Emunctories (Lat. emunctorius). The excretory ducts of the body.

Emydines, Emydina. A section of Chelonian reptiles or tortoises, having the genus *Emys* as the type.

Emydo-saurians, Emydo-sauria (Gr. ἐμύς, *a water-tortoise*, and σαῦρος, *a lizard*). The name of an order of the class *Reptilia*, including the tribe of Crocodiles (*Crocodiliens*, Cuv.), which form part of the order *Sauria* of the *Règne Animal*.

Enaliosauria (Gr. ἐνάλιος, *of the sea*, and σαῦρος, *a lizard*). A name applied to the entire group of extinct Saurians, in the organisation of which paddles, like those of the whale or turtle, were combined with the head and trunk of a crocodile. [ICHTHYOSAURUS; PLESIOSAURUS; SAUROPTERYGIA; and ICHTHYOPTERYGIA.]

Enamel (Fr. émail). A semitransparent or opaque glass. Common glass fused with oxide of tin is converted into common white enamel. Various coloured enamels are used in porcelain and enamel painting. [POTTERY.] The term *enamel* is also applied to the hard external covering of the teeth: it differs from the bony part of the tooth, or *dentine*, in containing less organic matter, the hardening principle being almost pure phosphate of lime. [TEETH.]

Enamel Painting (Fr. en émail or esmail, Lat. esmaltum or smaltum, Ital. smalto). In Painting, the art of applying vitrifiable colours on thin plates of metal (gold or copper) which are melted on to them, or on pottery, or even glass itself: the glass painting of the present time is chiefly enamelled. This art was practised by the ancient Egyptians and Etruscans. It was very commonly applied to ecclesiastical utensils and furniture during the middle ages, and was much in vogue with the Byzantine Greeks and with the Moors. The town of Limoges, in France, acquired especial celebrity for this class of art, on metal plate. During the Revival in Italy, especially in the Cinquecento period, it was much employed for table services of pottery and for the vessels of apothecaries. The famed Faenza or Majolica ware, of which so much is now preserved at the South Kensington Museum, is simply enamelled earthenware. The museum possesses also some fine examples of the *émaux de Limoges*, which are remarkable for the uniformity of their grey colouring. One of the first good enamellists, especially of portraits, was John Petitot of Geneva (1607–91). The various colours used are prepared from oxides of different metals, melted with some vitrescent mixture or *flux*, and laid on with a fine brush, the medium being oil of spike, or turpentine, or some other essential oil; and it is easy to conceive, says Mr. Aikin, 'how much the difficulties of this nice art are increased where the object is not merely to lay a uniform coloured glazing on a metallic surface, but also to paint that surface with figures and other designs that require extreme delicacy of outline, accuracy of shadowing, and selection of colouring. The enamel painter has to work, not with actual colours, but with mixtures which he knows from experience will produce certain colours after the operation of the fire.' This work requires several firings. The outline is first burnt in, after which the parts are filled up gradually with repeated burnings to the last finishing touches.

The principal colours are oxides of lead, platinum, uranium and chromium: different colours require different treatment. Silica, borax, and red oxide of lead form a flux for some colours: the oxides of iron and manganese are not approved of. The enamel is made opaque and white by oxides of tin or antimony. See the Edinburgh *Philosophical Magazine* for June 1837, which contains a notice of enamel painting by Mr. Alfred Essex; and De Laborde's *Notice des Émaux du Louvre, Histoire*, Paris 1852.

Enarthrosis (Gr. ἐνάρθρωσις, from ἄρθρον, *a joint*). The ball-and-socket joint.

Encampment. In Military affairs, the position occupied by an army, or body of troops, having pitched tents or erected huts for temporary lodgings. [CAMP.]

Encanthis (Gr. ἐγκανθίς, from κανθός, *the angle of the eye*). A small tumour or excrescence growing from the inner angle of the eye.

Encarpus (Gr. ἔγκαρπος, *containing fruit*). In Architecture, the festoons on a frieze, consisting of fruits, flowers, leaves, &c.

Encaustic (Gr. ἐγκαυστική, from καῦσις, *a burning*). A common method of painting, and the most durable of those employed by the Greeks, so called from the process of burning the picture in when completed. It was not developed until the later or more perfect period of Greek art. The pictures were executed with wax colours (ceræ), and the whole was afterwards burnt in with a hot iron; the painter himself signing his work with the word ἐνέκαυσεν (*burnt it in*), as Νικίας ἐνέκαυσεν. These pictures were executed with the cestrum [CESTRUM] and with the pencil: the colours though mixed with wax could be laid on with water. The effect of an encaustic picture cannot have been very different from the ordinary *tempera* or water-colour picture, as the men who practised either were equally celebrated; and Pausias, an encaustic painter, undertook to repair the pictures of Polygnotus at Thespiæ, which were in *tempera*. Both water-colour and *tempera* pictures were polished with a wax or encaustic varnish. The same method was applied to the colouring and varnishing of statues. [POLYCHROMY.] A common method of encaustic was used for colouring ships; the colours were laid on with a brush, hot; but this scarcely comes under the category of fine art. If the colours were not laid on with water on the finer pictures, the cestrum apparently served the purpose quite as well. The finer blending of tints being effected by the cauterium or hot iron, some resin was necessarily mixed with the colours to enable them to harden after the process of burning in. (Wornum, *Epochs of Painting*, 1859)

Enceinte (Fr.) or **Body of the Place.** In Fortification, the line of works which forms the main enclosure of a fortress.

Encephalocele (Gr. ἐγκέφαλος, *the brain*, and κήλη, *a tumour*). Hernia of the brain. There are two kinds of this disease: one occurs in young infants, before the skull is completely ossified; the other presents itself after the destruction of a part of the skull in consequence of disease, accident, or the operation of the trepan.

Encephalon (Gr. ἐγκέφαλος, *within the head*). The brain. The contents of the cranium.

Enchantment (Fr. enchantement; Lat. incantamentum, from incantare, *to sing*). The name given to the charms or ceremonies to which magicians have recourse in the practice of their art. [MAGIC; DEMONOLOGY.]

Enchasing. [CHASING.]

Enchiridion (Gr. ἐγχειρίδιον, from ἐν, *in*, and χείρ, *the hand*). In Literature, a brief and useful compilation; a *manual*. The ethical treatise of Epictetus is termed his *Enchiridion*.

Enclave (Fr.). In Heraldry, anything let into another, especially when the piece so let in is square.

Enclitics. [PARTICLES.]

Encratites (Gr. ἐγκρατής, *temperate*). In Ecclesiastical History, a Gnostic sect who condemned marriage. (Eusebius, *Hist. Eccl.* iv. 29.)

Encrinital Limestone. The name given occasionally by geological writers to the carboniferous limestone of the upper Palæozoic period, parts of which are so loaded with the fragments of encrinites that the whole mass seems made up of these fossils.

Encrinites. [CRINOIDEANS.]

Encumbered Estates Act. [INCUMBERED ESTATES ACT.]

Encyclopædia. [CYCLOPÆDIA; DICTIONARY.]

Encyclopædists (Fr. encyclopédistes). A name given to the French writers of the last century, whose works and influence, by stimulating freedom of enquiry and discussion, prepared the way for the Revolution.

Encystation (Gr. ἐν, and κύστις, *a bag*). The process undergone by certain Infusoria previous to fission. They coat themselves with a secretion of gelatinous matter, which gradually hardens and encloses the body in a *cyst*. Sometimes peculiar vesicular bodies become formed in the interior of such cysts, through which they finally burst, and becoming ruptured at the apex, give exit to the embryos contained in their interior.

Encysted. A term applied to tumours which are enclosed in a sac or cyst.

Endecagon or **Undecagon.** [HENDECAGON.]

Endellionite. A name given to the triple sulphuret of antimony, lead, and copper found in the mine Huel Boys, in the parish of Endellion, Cornwall. [BOURNONITE.]

Endemic (Gr. ἔνδημος, *among the people*). A disease peculiar to a certain class of persons, or to a certain district. Thus, agues or intermittent fevers are endemic in low countries, the *goître* in the Alps and parts of Derbyshire, the *plica Polonica* in Poland. [EPIDEMIC.]

Endermic Method. The application of medicinal agents to the denuded dermis. A blister is first usually applied: when the cuticle is elevated, an opening is made in it to allow the serum to escape, and the medicine is then applied to the dermis, either with or without removing the cuticle. Morphia, strychnia, and various other agents have been thus applied.

Endive. An annual or biennial herbaceous composite plant, used in salads, the *Cichorium Endivia* of botanists.

Endless Screw. A piece of mechanism formed by combining the screw with a cog-wheel, or by making a screw act on the threads of a female screw sunk in the edge of the

wheel. The axis of the screw may be either in the plane of the wheel, or at right angles to it; in the latter case it is called the *American endless screw*. In its mechanical principle the endless screw is a combination of the inclined plane and the lever.

Endocarp (Gr. ἔνδον, *within*, and καρπός, *fruit*). The inner coat or shell of a fruit, as the stone of a Cherry.

Endochrome (Gr. ἔνδον, and χρῶμα, *colour*). The colouring matter of plants.

Endogens (Gr. ἔνδον, and γίνομαι). One of the primary classes of plants, so called because their stems grow by successive additions to the inside; that is to say, by the addition of woody vessels towards the interior, so that the outer part is the oldest and hardest. They have no woody rings as in Exogens, and no true medullary rays. They are usually known by the veins of their leaves running parallel with each other, without branching or dividing. Grasses, Lilies, the Asparagus, and similar plants belong to this class, which in warm countries contains trees of large size, such as Palms and Screw Pines.

Endophyllous (Gr. ἔνδον, and φύλλον, *a leaf*). The young leaves of Monocotyledons, from their being evolved within a sheath, while those of Exogens are not so enclosed.

Endopleura (Gr. ἔνδον, and πλευρά, *the ribs or side*). In Botany, the internal integument of a seed.

Endorhizae (Gr. ἔνδον, and ῥίζα, *a root*). A term invented by Richard for the embryo of Monocotyledons, in which the radicle has to rupture the integument at the base of a seed prior to entering into the earth, appearing as if it came from within the mother root.

Endorse (from Lat. in, and dorsum, *the back*). In Heraldry, the smallest diminutive of the pale.

Endorsement. [EXCHANGE.]

Endosiphonites (Gr. ἔνδον, *internal*; σίφων, *a tube*). A genus of extinct Cephalopods, with chambered convolute discoidal shells, having the siphon placed at the inner side of the turns, as in the Spirula. The *Endosiphonites* characterise the slate rocks of the Cambrian system, and have not yet been observed in the Silurian formation.

Endosmometer (from endosmose, and Gr. μέτρον, *measure*). In Physiology, an instrument invented by M. Dutrochet, to measure or demonstrate the rapidity with which one or other of two mixing fluids, of different densities, will pass into each other: and by which the less dense fluids are shown to pass with greater rapidity into the more dense fluids, than vice versâ: in other words, that *endosmosis* is more rapid than *exosmosis*. A simple form of the instrument is a graduated tube, expanded into a bell at one end, over which a portion of membrane may be tied. If the bell be filled with a fluid of much density, such as a strong solution of salt, and be immersed in one of less density, as water, the water will endosmose, or pass into the solution, more rapidly than the solution will exosmose or pass out. But if the water were put into the bell and the saline solution outside, the directions of the currents would be reversed. In both cases, however, the currents would continue until the two fluids were equally mixed on both sides of the membrane.

Endosmose (Gr. ἔνδον, and ὠσμός, *a thrusting*). The transmission of gaseous bodies, or vapours, or liquids, through membranes or porous substances from without inwards.

Endosperm (Gr. ἔνδον, and σπέρμα, *seed*). The albumen of seeds.

Endostome (Gr. ἔνδον, and στόμα, *the mouth*). The passage through the inner integument of a seed immediately below the part called the foramen.

Endothecium (Gr. ἔνδον, and θήκη, *a cell*). The fibrous cellular tissue lining an anther.

Endowments. [FOUNDATION.]

Endymion (Gr. Ἐνδυμίων). In Greek Mythology, a youth loved by Selênê, who plunged him into an everlasting sleep. The local legends of Elis made him a son of Aëthlios and Calycê; other legends spoke of him as a son of Zeus and Protogeneia. These names explain themselves. The word Endymion expresses the plunge of the setting sun into the sea: he is spoken of as the son of Aëthlios, the struggling one, because the sun was held to toil all day, like Hercules, for the benefit of man; while Protogeneia, his mother, is the early dawn. So, again, he is made to sleep in the cave of Latmos, or forgetfulness, as Phœbus is the child of Leto, the dark and veiling night.

Eneid. [ÆNEID.]

Enema (Gr. *an injection*). A medicine injected into the rectum. A clyster.

Enfeoffment. [FEOFFMENT.]

Enfield Rifle. The arm with which all infantry in the British service are armed. It is named after the government factory at Enfield where it is made. There are two patterns: that of 1853—weight of rifle with bayonet 9 lbs. 12 oz., length 71·5 inches, length of barrel 39 inches, diameter of bore ·577 inch, three rifled progressive grooves spiral 1 turn in 78 inches; that of 1860—weight with bayonet 10 lbs. 4 oz., length of barrel 33 inches, 5 grooves. [SMALL ARMS; SMALL ARM AMMUNITION.]

Enfilade (Fr.). When a battery is placed at right angles to a line of troops or works, the shot from its guns raking that line, the fire is then called *enfilade*, the guns being fired with full charges. A trench or parapet is said to be *enfiladed* when guns are so placed that the shot can be fired into it in a direction parallel to its length.

Enfranchisement (Fr. franchise, *freedom or right*). In Law, the act of incorporating a person into any society or body politic; as where one is made a citizen or free burgess of a town corporate. In feudal usage, a villein was said to be enfranchised when he was made free by his lord; and hence is derived the popular signification of the term. For enfranchisement of land, see COPYHOLD.

Engaged Columns. In Architecture, columns attached to walls by which a portion of them is concealed; they never stand out less than one-half from the wall.

Engagement (Fr.). As a Military term, signifies a battle either by sea or land; but it is applied more frequently to the former, being synonymous with *action*. An engagement between two ships is called simply an *action*: between fleets, a *general action*. The conquered vessel strikes (hauls down) her colours, which are afterwards replaced by those of the enemy, hoisted over them. [BATTLE.]

Engine (from the Latin ingenium, used, like the Greek μηχανή, in the sense of a machine). In Mechanics, this term is used to denote generally any kind of machine in which two or more of the simple mechanical powers are combined together.

Engineering (from the Latin ingenium, used in the sense of an engine, like ARS, in Artillery, which see). Strictly, the art of managing engines; but latterly applied in a more extended sense, not only to that art, but to all manufacturing and building operations in which engines are used. It is divided into two branches, Military and Civil.

Military engineering, as a science, implies a knowledge of the construction and maintenance of fortifications, and all buildings necessary in military posts; and includes a thorough instruction on every point relative to the attack and defence of places. The science also embraces the surveying of a country for the various operations of war, and consequently an acquaintance with mathematics and facility in drawing. When at a siege the engineer has surveyed a place, he reports to the commander the weakest places, and those in which approaches may be made with most success. He draws the approaches, marks out the trenches, places of arms, batteries, and lodgements; and in general directs the workmen in these operations. He should possess a practical and theoretical knowledge of gunnery. In regard to the marine branch of military engineering, it requires of course a general acquaintance with the construction of vessels, jetties, moles, and other buildings of that description.

Civil engineering, as its name imports, does not include the branches above named, which specially belong to the art of war; but rather relates to the formation of roads and bridges, railroads, the construction of machinery to all purposes, the formation of canals, aqueducts, harbours, drainage of a country, &c. Till the year 1760 civil engineering was little cultivated in England or on the Continent as a distinct pursuit. At that period manufacturing began to be extended by the enterprise and capital of persons eminent for their deep knowledge and persevering industry. Internal navigation was a result of this extension; communication between harbours and warehouses, as well as facility of transport from factory to factory, became absolutely necessary; hence a system of canal navigation, which will perhaps not be entirely superseded by the modern railroad. Before this time, a few jetties and piers of defence were thrown out in our seaports; but these were deteriorated sadly from the old Roman models. These ports have since become harbours of refuge, and some of them are capable of containing large navies. The introduction of the system of the ponts et chaussées into France about this time also gave a great impulsion to the studies of the civil engineer; and the bridges of Huppeau, Perronet, De Cessart and Smeaton may be considered to mark an epoch in the art. The application of the steam engine to almost every purpose, independently of its importance in manufactures, has smoothed the difficulties formerly experienced in executing great works; and the numerous classes of new materials lately introduced have considerably extended the limits of the engineering profession. The substitution of the locomotive for horse traction, and the countless modifications of the wonderful power thus placed within the reach of engineers, have so materially changed the whole face of the science, that at the present day it would be necessary to write treatises on every branch of natural philosophy if it were desired to give a complete sketch of the duties of the civil engineer. The civil engineer cannot design any works for the water supply, the drainage, or the lighting of a town, without being acquainted with the principles, at least, of the chemistry of materials, the action and reaction of the water, the philosophy of light, and the nature of the materials employed by him to produce the effect. So also the mining engineer is bound to study the laws of the metals on which he works; whilst the mechanical engineer must be practically acquainted with the properties of the materials which he is employed to convert, the powers of motion, and the capabilities of producing it. The civil engineer, properly speaking, should bring to his pursuit a mind stored with every branch of applied sciences that can be enlisted in his profession.

Engineering Geology. The branch of applied geology relating to the consideration of the earth and of the various rocks at its surface, as the basis of engineering operations. Thus, earthworks, tunnels, embankments, cuttings, the artificial drainage of large tracts by operations dependent on the subsoil and the rock, water supply to large towns, and the selections of sites for various purposes, all depend on geological considerations, and not unfrequently these are of vital importance to the well-being of mankind.

The geological considerations that affect questions of this kind are chiefly mechanical and structural; as, for instance, a knowledge of the laws that govern the deposit of rocks in water, as stratified mud and sand; the laws of metamorphism, by which mud and sand are converted into limestone, sandstone, or clay, and so further into marble, quartzite, and slate; the laws according to which rocks have been dried,

fractured, upheaved, faulted, and brought into their present position; and lastly the sequence of rocks, as determined in the country where the operations are to be carried on and the knowledge exercised.

In ordinary engineering operations, as for railways, canals, or roads, the stability of earthworks may depend on the underlying rock. It is possible that by an alteration in the natural drainage, produced by a deep cutting, ground before quite permanent may become shifting, for by the trickling of water through a bed of sand or marl once cut through, not only is the support removed, but a sliding surface is prepared. Everything in such cases depends on the dip of the beds. If that is such as to render it probable that mischief would ensue, the injury when foreseen may be prevented; otherwise there is little to be done.

In tunnels, a knowledge of the stratification is essentially necessary, as without it no trustworthy estimate can be formed. By enabling the engineer to know what is the probable rock at a certain depth, and whether water is likely to come out when that depth is reached, and if so under what pressure, geology lays him under deep obligations

Drainage of land on a large scale, required only under certain geological contingencies, is greatly assisted and rendered more economical by a due application of geological knowledge. The fact that certain rocks allow water to pass freely through them, while others stop its passage entirely, is not less important in reference to those rocks that are far away out of sight, than those at the surface. Thus calculations not referring to geological inferences will have small value and may lead to serious error. So, with regard to the places selected for storing water for large towns, the applicability of these depends on the underlying rocks, quite as much as on the rocks at the surface. The latter may be permeable without seeming so; they may be connected with permeable rocks in such a way as to injure the quality of water stored in them; and lastly there may be limits to their retentive powers, only known by reference to surrounding geological conditions.

In military as in civil engineering, a knowledge of geology is desirable. Thus in the selection of a place for encampment, not only the presence of water, but freedom from fever ought to be a matter for consideration. Many important suggestions are offered at once in reference to these matters by a consideration of the geological phenomena.

Lastly, to emigrants, and especially to those whose position involves the responsibility of selecting a place for a permanent settlement, the state of the subsoil and underlying rocks, and the conditions of water supply, are much more important than has often been suspected.

Engineers, Royal. The corps intrusted with the construction of and the keeping up of fortifications, and all military works and buildings. [ENGINEERING.] Before the peace of 1763 the duties of engineers were performed by officers taken from the army generally; about this time the engineers were made into a permanent corps, and in 1772 the first company of sappers and miners was formed at Gibraltar. In 1783, the engineers were raised to be a royal corps, and in 1812 the sappers and miners were organised into a body of well-trained men. Until 1857 the non-commissioned officers and men were called *sappers and miners*, but this designation was then abolished, and they became royal engineers. The corps, which consists of over 5,000 men, is divided into forty companies, four of which are employed on the Ordnance Survey, six are at Chatham, and the remainder on works at home and abroad. Only men skilled in particular trades are enlisted for this corps.

England, Church of. The period at which Christianity was first preached in this country has not been settled with any certainty; but there was certainly a British church existing in the island at the time of the mission of Augustine, in the year 597, to convert the Saxons. The British church, however, at that time had shared the fate of the general British population, and had been pent up by the pressure of the heathen invaders within narrow limits at the extremities of the island. It can hardly be thought to have retained sufficient vigour to have effected the conversion of the barbarians. If such be the case, we must allow that Christianity in Britain owes at least its second foundation to the Romish see; but possibly the influence of the more primitive religion of the Britons may have had its effect in rendering the submission of the Anglo-Saxons to the see only partial. Certain it is, as has been shown from existing homilies, that some of the principal novelties of the Romanists were unknown to or repudiated by the English church at least up to the time of Edward the Confessor. The intercourse with France, which began to take place in that reign, and the superstitious temper of the monarch, prepared the way for the introduction of the Romish power, which was furthered by the necessities of the usurpers William and Stephen. Under Henry II. royalty took the alarm, and a fierce struggle took place, in which the papal authority was eventually victorious. Under John, the triumph of Romanism was completed, when the crown of England was actually given into the hands of Innocent III. But at that very time the seeds of the Reformation were being sown among the lowest classes: sects of strolling fanatics were constantly appearing and passing away, misguided themselves, but drawing the attention of the people to the errors of the church; and at length, under the impulse given by the learning of Wiclif, taking a definite and lasting shape under the name of the Lollards. A general reformation in opinion was almost at hand, when Henry VIII. threw off the supremacy of the pope. But while he encouraged the Reformers by that step, he checked them by severe enactments upon points of belief; and, as far as he is concerned, it may be doubted whether he at all assisted the developement of

the Reformation. The church of England was first reformed by law on the accession of Edward VI.; but many points of doctrine and discipline were left untouched; and the enactments of Elizabeth, by which its whole constitution was finally settled, followed rather than preceded the expressed convictions of the nation. (For the variations that have since taken place in the services of the church, see COMMON PRAYER.) The government of the church of England is episcopal, and the bishops sit in the House of Lords by virtue of the temporal baronies into which their benefices were converted by William the Conqueror. This constitution was subverted on the success of the Great Rebellion, and presbyterianism established in its stead; but the episcopal form was restored in 1660 with the return of Charles II., when the Liturgy of the church of England was legalised by statute. [UNIFORMITY, ACT OF.]

The church of England is established in Ireland, or rather the churches of the two countries are one in doctrine and discipline; and in some of the old North American colonies (especially Virginia) it enjoyed rights and dignity. But with the independence of those colonies, the church of England ceased to exist there; and the episcopal church of America, affiliated with but independent of the English communion, began its existence. The episcopal church of Scotland, again, though in doctrine and discipline nearly resembling that of England, is distinct from it. But with the extension of British colonisation, the local extent of the church of England has of late years greatly increased; there are now forty colonial bishops, and some steps have been lately taken towards the establishment of missionary bishops without any British or colonial diocese.

English. In Printing, the name of a type five sizes larger than that used in this work. A type twice the size of this is called *two-line English*. [TYPE.]

English Architecture. [ARCHITECTURE, ENGLISH.]

Engrailed. In Heraldry, any object edged with small semicircles, the points turned outwards.

Engrailment. The ring of dots round the edge of a medal.

Engraving (Sax. grafan, *to dig*, as Gr. γράφειν, *to write* or *paint*, meant originally *to scratch* or *scrape*). The art of producing by incision or corrosion designs upon blocks of wood, plates of metal, or other materials, from which impressions or prints upon paper or other soft substances are obtained by pressure. Engraving, as an art, seems to have nearly the same relation to design and painting as typography bears to written language; and its utility and great importance must be obvious to everyone, from its capability of giving a boundless circulation to representations of the most valuable examples of the arts and of objects connected with science. By some authors it is placed among the representations called *monochromus* (μονοχρώματοι).

Xylography, or wood-engraving, was the earliest method practised; but its origin is involved in obscurity. If we might rely on Du Halde (*Description, &c. de l'Empire de la Chine*, 4to. 1736), it may possibly have been known in China 1,120 years before Christ; though we think its invention is of a much later period, as the Chinese were not acquainted with the art of making paper till 95 B.C. It has been stated that this art was introduced into Europe from China, through the intercourse of the Venetian merchants with its inhabitants; for it is proved that engraving on wood had been practised in that part of Italy which borders on the Adriatic as early as the thirteenth century. The first wood engravings in Europe of which anything is known with certainty were executed in 1285, by a brother and sister of a noble family of the name of Cunio. They represent the actions of Alexander; and though doubts of their authenticity are expressed by Heinecken, Mr. William Young Ottley, the author of the *History of Engraving*, thinks otherwise. But for the accidental discovery by Temanza, a Venetian architect, of a decree of the magistracy of Venice, in 1441, we might have been without positive proof of the practice of the art in Italy previous to 1467. This decree, dated October 11, 1441, states in substance that the art and mystery of making cards and printed figures had fallen to decay, owing to their extensive importation; and in order that encouragement might be given to native artists rather than to foreigners, it was ordered that no work of the said art, printed and painted on cloth or paper—viz. altar-pieces or images and playing cards, and whatever other work of the said art is done with a brush and printed—should be allowed to be brought into the city, on pain of forfeiting the works, besides a pecuniary penalty. This decree plainly indicates that wood-engraving had been practised in Venice some years before that date. In Germany and the Low Countries, block books seem to have existed as early as 1420, and to have given Gutenberg the hint for using movable types. At Rome, in 1467, a work entitled *Meditationes Johannis de Turrecremata*, issued from the press of Ulric Han, embellished with wood engravings, in which the design and execution of an Italian artist are evident. The decorations of the work of Valturius by Matteo Pasti, of Verona, published five years afterwards, exhibit considerable spirit and accuracy; and before the end of the fifteenth century the art had been carried to great perfection, as may be proved by the delicacy and purity with which the designs are engraved in the celebrated work of Francesco Colonna, entitled *Poliphili Hypnerotomachia*, and published in folio by Aldus. This book, now extremely rare, is full of plates, some of great beauty, from wood blocks. At this period, however, the discovery of copper-plate engraving had been made, and to this the more ancient art gave place. Maso Finiguerra, a goldsmith and sculptor of Florence, and pupil of Masaccio, about the middle of the fifteenth century, seems

from the most authentic accounts to have been the person to whom the world is indebted for the discovery. In his time, and for a considerable period previously, it was the practice to decorate church and other plate with works in *niello*, which were designs hatched with a steel point upon gold or silver, then engraved with the burin, and run in, while hot, with a composition called *niello*—a compound of silver, lead, copper, sulphur, and borax, which was more easily fusible than silver, and of a black colour. In order to preserve copies of their designs, the artists were in the habit before filling the design with the niello to take impressions of the plates with liquid sulphur as well as impressions of their designs on damp paper. But Finiguerra discovered, by accident, that he could take equally good impressions from the plate itself; and with a mixture of soot and oil he filled the cavities of the engraving, and by pressing with a roller obtained impressions on the paper, having, as Vasari says, all the appearance of drawings done with a pen. An impression from a Pax, representing the 'Coronation of the Virgin,' dated 1452, is now in the Library at Paris, and is the oldest metal print: the original plate is still preserved at Florence. (Zani, *Materiali alla Storia dell' Incisione &c.* Parma 1802.) Bartsch, in his *Essay on the History and Discovery of the Art of taking Impressions from Engravings*, prefixed to the thirteenth volume of his work *Le Peintre Graveur*, very unwillingly admits the invention to have originated with Finiguerra, though he claims for the Germans the merit of applying it to practice for the multiplication of copies of pictures, &c.; but to this the opposing arguments of Mr. Ottley are so powerful that the subject is not likely to be again mooted. Finiguerra was followed by Baccio Baldini, a goldsmith of Florence, who, according to Vasari, employed Sandro Botticelli to design for him; but it does not appear likely that such an artist as Botticelli could have resigned himself to employment in such works as Baldini would be constantly requiring. Baccio's works were numerous, and are of course much sought after by collectors. Botticelli, a painter of eminence as well as an engraver, was a native of Florence, where he was born in 1447; he died in 1515. Among the works which he engraved from his own designs are subjects illustrative of Dante, and a number of prints of prophets and sibyls. Contemporary with him flourished Antonio del Pollajuolo, and rather later Gherardo and Robetta; but the art still remained dry in execution, and more to be admired for correctness of drawing and design than for any attempt at relief or effect. There can be no doubt that at this period it was practised at Rome, though the Venetian state and other parts of the north of Italy furnished a more abundant supply of artists, of whom Francesco Squarcione, Andrea Mantegna, Girolamo Mocetto, Marcello Fogolino, Benedetto Montagna, Bramante the architect, Gio. Bat. del Porto, Giovanni Maria, and Giovanni Antonio di Brescia were among the most eminent. The works of Mantegna exhibit great marks of improvement on the Florentine school.

In Germany and the Low Countries the art of engraving had made extraordinary progress during the fifteenth century; and the name of Martin Schoen or Schongauer must not be forgotten. This artist, who was also a painter and goldsmith, was the father of the German school of engraving. He was a native of Ulm, where he was born about 1420. He began the practice of the art when it was in its infancy, and succeeded in carrying it to a great degree of perfection. He died at Colmar in 1488. Vasari relates that Michael Angelo, when young, was so pleased with a print by Schongauer, representing St. Anthony tormented by devils, that he copied it in colours. Israhel van Meckenem was another excellent master of this old school; he died in 1503. Albert Dürer, the most celebrated of the early engravers of Germany, was born at Nuremburg, in 1471. Skilled in many arts, and a painter of no ordinary powers, it is astonishing that, in a life not exceeding fifty-eight years, he should have succeeded also so eminently in that of engraving. On copper as well as wood his works exhibit specimens of executive excellence, which the experience of centuries has not been able to surpass. Dürer is supposed to have been the inventor of the art of etching, at least no etchings are known before those which are extant from his hand. Of his many works, his wood engravings are the most free and masterly. He died in 1528. Following Albert Dürer were Burgkmair, Schäufelein, Aldegrever his pupil, Hans Beham and his brother Bartholomew, Altdorfer, Binck, Goeding, Pencz, and Solis. Hans Holbein, who was a native of Augsburg and died in London in 1543, besides acquiring celebrity as a painter, is supposed to have been an engraver on wood, and to have executed many pieces; the most remarkable of which are the fifty-three prints called the *Dance of Death*, first published about 1530. Of the Dutch and Flemish schools, Lucas van Leyden must be considered the head. Born in 1494, at the place whence he derives his name, he was the contemporary and friend of Albert Dürer; to whom, though inferior in design, he was superior in composition. His works, which were both on wood and copper, are few in number. The Low Countries furnished a host of engravers, among whom it is unnecessary to name more than F. Floris, C. Cort, and the three Sadelers; Bloemart, who laid the foundation of the principles upon which lines become capable of expressing quality, colour, and chiaroscuro, which the French engravers afterwards improved; H. Goltzius and his pupils; Müller, and Lucas Kilian: the three last, though they handled the graver with great freedom and dexterity, fell into absurdities, which, however, were tempered and corrected by Matham and Saenredam. In the beginning of the seventeenth century the two Bolswerts appeared, whose style was much improved by the instructions of Rubens. Vorsterman, Pontius, and Peter de Jode the younger were of this school, which is dis-

tinguished for the success and correctness with which it transferred the picture to the copper. Rembrandt (1607–69), notwithstanding all his faults, claims a special notice in this place as an engraver. The 'Descent from the Cross,' and the print called the 'Hundred Guilder Print,' are extraordinary efforts of art. His portraits and landscapes are full of nature, expression, and character; and it is difficult to say whether he is more successful in his sunshine effects, than in the sober solemn twilight with which his varied subjects are enveloped. Vandyck has left a few specimens of etchings worthy of his name. Zeghers, Lutma, and above all Cornelius and John Visscher, exhibited great excellence in the art, which continued to advance under the hands of Waterloo, Jacob Ruysdael, and Paul Potter; the last of whom, in his etchings of animals, displayed a scientific acquaintance with drawing and anatomy, till his time unpractised.

We must now return to close the brief account of the Italian school, in which the appearance of Marcantonio Raimondi forms the most splendid era. Born at Bologna about 1475, he became the pupil of Francia, the great painter of that city. His master in the art of engraving is, however, unknown. We first hear of him at Venice, in 1506, whither Albert Dürer went to institute proceedings against him for pirating his prints, which had been copied by Raimondi with such wonderful accuracy that they were sold for the originals. But the proper sphere for Marcantonio was Rome, whither he soon bent his steps. There his merit soon gained him the friendship and esteem of Raphael, then in the plenitude of his glory, by whom he was employed to engrave from his designs. His first plate from a design by Raphael was the 'Lucretia,' soon after which he executed the 'Judgment of Paris.' His engravings after this master are very numerous; and though free from the blandishments of style, chiaroscuro, and local colour which the art has received since his time, such was his knowledge of drawing, such the beautiful character that pervades his works, that he is entitled to the highest rank in the art. Strutt considers him one of the most extraordinary engravers that ever lived. His school attracted to Rome artists from all parts; among whom may be enumerated Marco da Ravenna, Giulio Bonasone, Agostino de Musis, Enea Vico, and Nicolas Beatrizet. Some of the German artists whom we have named above—viz. Beham, Pencz and J. Binck—resorted to Rome for the benefit of Marcantonio's instructions. On the death of Raphael, he executed engravings of some of the works of Giulio Romano, and died in or before 1534. (Vasari, *Vite &c.* ed. Le Monnier, vol. ix.) Some of the principal pupils of Marcantonio have already been named; to them may be added Giorgio Ghisi, commonly called Mantuanus, and others of his family. Many of the Italian painters were extremely successful in engraving; among them Titian etched many landscapes; but none cultivated the art with more success than Agostino Carracci, who studied under Cornelius Cort, a Dutch engraver, born at Hoorn in 1536. His design and execution are equally to be admired; and had he but concentrated his lights more, and attended to local colour, he would have been exceeded by none. In the seventeenth century Della Bella, Callot (who, though born in France, belongs to the Italian school), Guercino, Salvator Rosa, and Claude continued the reputation of the art. At the latter end of this century was born Antonio Canaletto, originally a scene-painter, like his father Bernardo. His etchings opened an entirely new field in architectural engraving, and may be considered almost if not quite the first in which fine sparkling effects of light are introduced, and in which the darkest shadows partake of the transparency and clearness which Nature herself exhibits. J. B. Piranesi, who was born in Venice, and died in 1778, appeared about the middle of that century: he and his son Francesco, the latter born in Rome in 1748, are the most surprising architectural engravers that have ever existed, whether we consider the astonishing power or the number of their works. Their effective use of the etching needle surpassed all that has been done before or since. Of a more recent date, Volpato of Florence is a great name; besides his other works, he engraved almost all the celebrated performances of Canova with a delicacy, grace, and correctness of the first order.

The French school commenced about the middle of the sixteenth century with Noel Garnier, who was followed by many clever artists; but till the time of Louis XIV. it cannot be said to have been highly distinguished. At that epoch we have Gerard Edelinck, who, though born at Antwerp, belongs properly to the French school, and Gerard Audran. The former of these, who worked entirely with the graver, carried what is called colour in engraving to a much greater degree of perfection than had ever before been practised. The name of Gerard Audran, who engraved the well-known battles of Alexander after Le Brun, is conspicuous in the history of the art; his name, however, will descend to posterity with greater lustre from his engravings after the Italian school, and particularly those of Nicolas Poussin. Gerard Audran was born at Lyon in 1640, and died in Paris in 1703. John Audran, the last of the family who exercised the art, and nephew of Gerard, died in 1756. Nanteuil, the three Drevets, of whom Peter was the most eminent, Le Clerc, Chereau, Cochin, Beauvais, Simonneau Dupuis, and many other masters belong to this period; but Balechon and Wille, towards the middle of the century, outstripped all that had been done by their predecessors. Wille was a German; but his residence having been chiefly at Paris, he is always ranked among the French engravers. His extraordinary powers in imitating the qualities of objects, and his extraordinary clearness in the use of the graver, entitle him to a place of the first rank in the French school, which, since the age of Louis XIV., has been more distinguished for its great mechanical

skill, than for grace, correctness, and beauty in the higher departments of the art.

Till the middle of the seventeenth century England was indebted to foreign artists for the embellishment bestowed upon the typographical works she produced, as well as for such engravings, either in history, portrait, or landscape, as the taste of the nation required. Among the artists who visited England and made it their permanent or temporary residence were the Passes, Vaillant, Hondius, Vorsterman, Hollar, Blooteling, Dorigny, and several others. Payne, who died about 1648, and Faithorne, who executed many historical pieces and portraits in a masterly manner, were the earliest English engravers deserving mention. William Faithorne, son of the last named, was eminent as one of the earliest mezzotinto engravers. This invention, which is erroneously attributed to Prince Rupert, was the discovery of a German officer, Ludwig von Siegen, born at Utrecht in 1609. He executed his first mezzotint in 1642; it is a portrait of Amalia Elizabeth of Hanau. He taught his method of engraving to Prince Rupert in 1656-8, when both were residing in Brussels. Siegen was a major in the service of the duke of Wolfenbüttel, and was still living in 1676. There are seven plates by him. (Leon de Laborde, *Histoire de la Gravure en Manière Noire*, Paris 1839.)

After the two Whites, father and son, appeared Vertue, who was born in 1684. He was the scholar of Vandergucht, and from his many works must have been an artist of great industry and facility. The larger portion of his labours was confined to portraits. Vertue died in 1757, and left behind him in manuscript a history of painting and painters in England, which was afterwards published by Horace Walpole under the title of *Anecdotes, &c.* Jacob Houbraken executed some wonderful portraits at this time in England; he died in 1780. The works of Pond and Knapton can only be mentioned as continuing the history, though occasionally they possess some spirit; but Vivares, a Frenchman by birth, belonging, however, to the English school, and indeed the founder of it in landscape engraving, has in his works from the pictures of Claude shown talents which were the precursors of that pre-eminence in landscape engraving which this country has as yet perhaps exclusively possessed. Woollett carried execution to a far greater extent than Vivares, uniting with that engraver's spirit all the elegance, clearness, and delicacy of the French school, while to these he superadded every beauty that mechanical skill could effect. John Browne was a contemporary worthy of Woollett, whose works after Salvator, Both, and others are well executed. Sir Robert Strange distinguished himself by his great mechanical skill; the delicacy which he imparted to flesh has never been equalled. His principal engravings are from the Italian painters, especially Titian, Guido, and Correggio, and reflect great honour on the English school, which since his time has never been deficient in producing artists of the first class, of whom one of the most eminent was William Sharp, born in London in 1746. Strange was born in one of the Orkney Islands, in 1721, and died in 1792. Sharp died in London in 1824. Since his time the names of artists of talent might be here supplied to a very great extent: we shall merely mention those of Basire, Bartolozzi, Rooker, J. Heath, Byrne, Bromley, Lowry, Earlom, Raphael Smith, Holloway, Raimbach, R. Brandard, &c. In the present day the demand of prints for the embellishment of books has produced talent which perhaps might be more nobly employed in works of a higher order. In the enumeration of masters it will be seen that the name of Hogarth does not find a place; for which our reason is that his engravings partake more of the nature of pictures transferred at once to copper, often without proceeding through the intermediate stage. The number of pure line engravers is gradually diminishing, additional difficulties having been thrown in the engraver's path through the competition of photography.

Engraving on Wood, or Xylography.—In this branch of the art the material used is a block of box or pear-tree wood, cut at right angles to the direction of the fibres, its thickness being regulated by the size of the print to be executed. The subject is drawn on the block with a black-lead pencil, or with a pen and Indian ink, taking care that the whole effect is represented in the lines so drawn. The whole of the wood is then cut away, except where the lines are drawn, which are left as raised parts; in which point it is that this mode of engraving differs so essentially from copperplate engraving, wherein the lines are cut out or sunk in the metal, instead of being raised from it. The impressions from wood blocks are taken in the same manner as from printing types. (See the elaborate *Treatise on Wood Engraving, &c.*, by W. A. Chatto, with illustrations by John Jackson, 1839.)

Engraving on Copper is performed by cutting lines representing the subject on a copperplate by means of a steel instrument ending in an unequal-sided pyramidal point, such instrument being called a *graver* or *burin*, without the use of aquafortis; which mode will be seen below, under *Etching*. Besides the graver there are other instruments used in the process; viz. a scraper, a burnisher, an oil stone, and a cushion for supporting the plate. In cutting the lines on the copper the graver is pushed forward in the direction required, being held in the hand at a small inclination to the plane of the copper. The use of the burnisher is to soften down lines that are cut too deep, and for burnishing out scratches in the copper: it is about three inches long. The scraper, like the last, is of steel, with three sharp edges to it, and about six inches long, tapering towards the end. Its use is to scrape off the burr raised by the action of the graver. To show the appearance of the work during its progress, and to polish off the burr, engravers use a roll of

woollen or felt called a *rubber*, which is put in action with a little olive oil. The cushion, which is a leather bag about nine inches diameter filled with sand for laying the plate on, is now rarely used except by writing engravers. For architectural subjects, or in skies, where a series of parallel lines are wanted, an ingenious machine was invented by the late Mr. Wilson Lowry, called a *ruling machine*, the accuracy of whose operation is exceedingly perfect. This is made to act on an etching ground by a point or knife connected with the apparatus, and bit in with aquafortis in the ordinary way.

Etching is a species of engraving on copper or other metals with a sharp-pointed instrument called an *etching needle*. The plate is covered with a ground or varnish capable of resisting the action of aquafortis. The usual method is to draw the design on paper with a black-lead pencil; the paper being damped and laid upon the plate, prepared as above, with the drawing next the etching ground, is passed through the rolling press, and thus the design is transferred from the paper to the ground. The needle then scratches out the lines of the design; and aquafortis being poured over the plate, which is bordered round with wax, it is allowed to remain on it long enough to corrode or bite in the lines which the etching needle has made. Etching with a dry point, as it is called, is performed entirely with the point without any ground, the burr raised being taken off by the scraper. Etching with a soft ground is used to imitate chalk or black-lead drawings. For this purpose the ground is mixed with a portion of tallow or lard, according to the temperature of the air. A piece of thin paper being attached to the plate at the four corners by some turner's pitch, and lying over the ground, the drawing is made on the paper and shadowed with the black-lead pencil. The action of the pencil thus detaches the ground which adheres to the paper, according to the degree to which the finishing is carried; the paper being then removed, the work is bit in in the ordinary way. *Stippling* is also executed on the etching ground by dots instead of lines made with the etching needle, which, according to the intensity of the shadow to be represented, are made thicker and closer. The work is then bit in. *Etching on Steel* is executed much in the same way as in the process on copper. The plate is bedded on common glazier's putty, and a ground of Brunswick black is laid in the usual way, through which the needle scratches. It is then bit in, in the way above described.

Mezzotinto Engraving.—In this species of engraving, the artist, with a knife or instrument made for the purpose, roughs over the whole surface of the copper in every direction, so as to make it susceptible of delivering a uniform black, smooth, or flat tint. After this process the outline is traced with an etching needle; the lightest parts are then scraped out, and after these the middle tints so as to leave a greater portion of the ground, and so on according to the depth required in the several parts of the work.

Aquatinta Engraving somewhat resembles the effect of an Indian-ink drawing. The mode of effecting this is (the design being already etched) to cover the plate with a ground made of resin and Burgundy pitch or mastic dissolved in rectified spirit of wine, which is poured over the plate lying in an inclined position. The spirit of wine, from its rapid evaporation, leaves the rest of the composition with a granulated texture over the whole of the plate, by which means a grain is produced by the aquafortis on the parts left open by the evaporation of the spirit of wine. The margin of the plate is of course protected in the usual way. After the aquafortis has bitten the lighter parts they are *stopt out*, and the aquafortis is again applied, and so on as often as any parts continue to require more depth. Formerly the grain used to be produced by covering the copper with a powder or some substance which took a granulated form, instead of using the compound above mentioned; but this process was found to be both uncertain and imperfect. In the compound the grain is rendered finer or coarser, in proportion to the quantity of resin introduced. This mode of engraving was invented by a Frenchman of the name of St. Non, about 1662. He communicated it to Jean Baptiste le Prince, who died in 1781; from the latter it was acquired by Paul Sandby, who introduced it through the medium of Mr. Jukes into England. It has been practised in this country with much greater success than elsewhere.

Etching on Glass.—The glass is covered with a thin ground of beeswax; and the design being drawn with the etching needle, it is subjected to the action of sulphuric acid sprinkled over with pounded fluor or Derbyshire spar. After four or five hours this is removed, and the glass cleaned off with oil of turpentine, leaving the parts covered, with the beeswax untouched. This operation may be inverted by drawing the design on the glass with a solution of beeswax and turpentine, and subjecting the ground to the action of the acid.

Engraving on Stone or *Lithography* (Gr. *λίθος, a stone*, and *γράφειν, to write or draw*). A modern invention, by means of which impressions may be taken from drawings made on stone. The merit of this discovery belongs to Aloys Senefelder, a musical performer of the theatre at Munich, where he died in 1834. The following are the principles on which the art of lithography depends: First, the facility with which calcareous stones imbibe water; second, the great disposition they have to adhere to resinous and oily substances; third, the affinity between each other of oily and resinous substances, and the power they possess of repelling water or a body moistened with water. Hence, when drawings are made on a polished surface of calcareous stone with a resinous or oily medium, they are so adhesive that nothing short of mechanical means can effect their separation from it; and whilst the other parts of the stone take up the water

poured upon them, the resinous or oily parts repel it. Lastly, when over a stone prepared in this manner a coloured oily or resinous substance is passed, it will adhere to the drawings made as above, and not to the watery parts of the stone. It was formerly thought that this country did not possess a sort of stone like that of Germany suitable to the purposes of lithography; this, however, is now known to be erroneous, as the neighbourhood of Bath abounds with it, being the white *lias*, which lies immediately under the blue. It is also found in Scotland. The ink and chalk used in lithography are of a saponaceous quality: the former is prepared in Germany from a compound of tallow soap, pure white wax, a small quantity of tallow, and a portion of lamp-black, all boiled together, and when cool dissolved in distilled water. The chalk for the crayons used in drawing on the stone is a composition consisting of the ingredients above mentioned, but to it is added when boiling a small quantity of potash. After the drawing on the stone has been executed and is perfectly dry, a very weak solution of vitriolic acid is poured upon the stone, which not only takes up the alkali from the chalk or ink, as the case may be, leaving an insoluble substance behind it, but it lowers in a very small degree that part of the surface of the stone not drawn upon, and prepares it for absorbing water with greater freedom. Weak gum water is then applied to the stone, to close its pores and keep it moist. The stone is now washed with water, and the daubing ink applied with balls as in printing; after which it is passed in the usual way through the press, the process of watering and daubing being applied for every impression. Any coloured ink may be used in lithography; hence, by using various stones, with different portions of a picture drawn on them, so arranged as to register perfectly, a facsimile of a picture can now be printed. This method of reproducing pictures or drawings is now popularly known as *Chromolithography*.

There is a mode of transferring drawings made with the chemical ink on paper prepared with a solution of size or gum tragacanth, which being *laid on the stone and passed through the press* leaves the drawing on the stone, and the process above described for preparing the stone and taking the impressions is carried into effect.

In Germany many engravings are made on stone with the burin, in the same way as on copper; but the very great inferiority of these to copper engravings makes it improbable that this method will ever come into general use.

Perhaps one of the greatest advantages of the art of lithography is the extraordinary number of copies that may be taken from a block. As many as 70,000 copies or prints have been taken from one block, and the last of them nearly as good as the first. Expedition is also gained, inasmuch as a fifth more copies can be taken in the same time than from a copperplate; and as regards economy, the advantage over every other species of engraving is very great.

Engrossing. (Fr. grossoyer, *to write in a large hand*). The writing of a deed in proper legible characters. Among lawyers it more particularly means the copying of any writing upon parchment or stamped paper. In statute law, engrossing means the buying up of large quantities of any commodity in order to sell it again at an unusually high price. [FORESTALLING.]

Enhanced. In Heraldry, bearings placed in the shield above their usual situation.

Enharmonic. In Music, a term having reference to the distinction between notes which, though different in themselves, are represented by the same key on the pianoforte. Thus a transition from G♯ to A♭, or from D♭ to C♯, is called an *enharmonic transition*.

Enigma (Gr. *αἴνιγμα*). A proposition put in obscure or ambiguous terms to puzzle or exercise the ingenuity in discovering its meaning. In the present day, the enigma serves merely to beguile a leisure hour; but formerly it was a matter of such importance that the Eastern monarchs used to send embassies for the solution of enigmas. The enigma which Samson proposed to the Philistines, and the still more famous riddle of the SPHINX [which see], are well known. About the seventeenth century the enigma, which had been for centuries neglected as a species of literary display, again came into favour; and in France particularly it was cultivated with so much zeal, that several grand treatises were dedicated to its history and characteristics.

Enlistment. In Military and Naval affairs, a voluntary engagement to serve as a private soldier or sailor, either for a fixed or unlimited period. Unlike the armies of the Continental nations, whose ranks are generally supplied by conscription, the troops of the British army in all its departments are obtained by voluntary enlistment. About a century ago, it was usual to engage recruits for the period of three years; but the present practice is to enlist for certain defined numbers of years. For the infantry, the period is ten years; for the cavalry and artillery, twelve years; provided the recruit be upwards of eighteen years of age, otherwise the difference between his age at enlistment and eighteen years is added to each period. No boy may be enlisted under fourteen years of age; and foreigners not British subjects can only be allowed to serve in a proportion not exceeding one in every fifty men of a battalion. The Acts regulating this subject are the 10 & 11 Vict. c. 37, 18 Vict. c. 4, and 21 & 22 Vict. c. 55. By an Act passed in 1819, called the Foreign Enlistment Act, no British subject was allowed to enter foreign service without permission from the crown; and though this Act was suspended for three successive years in favour of the troops raised in this country for the service of the queen of Spain, it is once more in full operation. [RECRUITING.]

The navy of Great Britain is also manned by voluntary enlistment; though in time of war,

or on other great emergencies, IMPRESSMENT [which see] is often resorted to. The period of engaging to serve in the navy was limited, until 1857, to the period during which the ship for which the man might volunteer should be in commission; but by an Act of Parliament of that year, a new and valuable class of men was originated, viz. *continuous service men*. These covenant to serve for a given number of years in any ship to which they may be posted. They have advantages in the way of pay, leave, pension, &c., to other sailors.

Enmanché (Fr. *resembling a sleeve*). In Heraldry, lines of about half the breadth of the chief drawn from the centre of the upper edge of the chief to the sides.

Enneagon or **Nonagon** (Gr. ἐννέα, *nine*; γωνία, *angle*). A plane rectilineal figure of nine sides and angles. The area of a regular or equilateral and equiangular enneagon is approximately 6·18182 times that of the square on one of its sides.

Enneandria (Gr.). In Botany, the name of the ninth class in the Linnæan system. The flowers are hermaphrodite, with nine stamens.

Enneandrous. In Botany, having nine stamens.

Ennui. A French word, signifying the listlessness or languor which prevails during seasons of mental inactivity, satiety, or exhaustion. The Italian word *noja* corresponds to *ennui*.

Enoch, Book of. This book, from which a prophecy is quoted in the Epistle of St. Jude, is mentioned by most of the Fathers down to the time of Augustine and Jerome. It was then forgotten or lost, nor was it recovered till the celebrated traveller James Bruce brought two Ethiopian copies to Europe in 1773. In 1821 an English translation was published by Archbishop Laurence, who thinks that the book was composed within about fifty years immediately preceding the birth of Christ, and remarks the singularity that a book written so short a time previously could have 'so far imposed on the public, as to be reputed by any the genuine production of the patriarch Enoch.'

Enrollment (in Legal orthography, more properly, Inrollment). Signifies in law the registering or entering of any document or lawful act in the rolls of the chancery, or superior courts of common law, or in the records of the quarter sessions. Such enrollment was rendered necessary in different cases by statute; as a deed of bargain and sale in order to pass lands must be enrolled in one of the courts of record at Westminster, or by the clerk of the peace in any county, by 27 Hen. VIII. c. 16. Every deed before it is enrolled is to be acknowledged to be the deed of the party before a master in chancery, or a judge of the court in which it is enrolled.

Ens. A term applied by the old chemists to the essence or condensed virtues of substances.

ENS. In Metaphysics, a term denoting *entity* or *being* (Gr. τὸ ὄν). *Ens reale*, or positive being, is distinguished from *Ens rationis*, which exists only in idea.

Ensemble (Fr.). In the Fine Arts, a term denoting the masses and details considered with relation to each other.

Ensign (Fr. enseigne, Ital. insegna, Lat. insignia). The national flag carried by a ship, and usually hoisted at the peak or on a flagstaff at the stern. British men-of-war formerly carried a red, a white, or a blue ensign, according to the colour of the flag of the admiral in command of the station; but by a rule of 1864, all men-of-war carry the St. George's ensign, viz. a white ensign with a red cross and the union jack in the left-hand upper quarter. The red ensign is used by other government vessels, transports &c., and the blue ensign is abandoned to the merchant service.

Ships do not display their ensigns at sea, except in meeting strangers, when they show their national ensign. In harbour the ensign is not shown before eight A.M. nor after sunset.

The ensign hoisted with the upper corner downwards, is the signal of distress.

The English ensign is a red, white, or blue flag, having the union in the upper corner next the mast.

ENSIGN. A commissioned officer, lowest in rank, in a regiment of infantry. An ensign performs the usual duties of a subaltern, and the junior ensigns carry the colours of the regiment.

Ensigned. In Heraldry, any charge which is ornamented.

Entablature. In Architecture, the whole of the parts of an order above the column. The assemblage is divided into three parts: the *architrave*, which rests immediately on the column; the *frieze* next, over the architrave, being the middle member; and the *cornice*, which is the upper member: the first and last are variously subdivided in the different orders. [ORDERS.]

Entail. [FEE TAIL.]

Entasis (Gr.). In Architecture, a delicate and almost imperceptible swelling of the shaft of a column, to be found in almost all the Grecian examples, adopted to prevent the shafts being strictly frusta of cones. This refinement, which is alluded to in the second chapter of the third book of Vitruvius, was first observed by Mr. Allaston in 1814, in the Athenian edifices.

Ente (Fr.). In Heraldry, any engrafted emblazonment.

Entelechy (Gr. ἐντελέχεια). A peripatetic term, invented by Aristotle in order to express an object in its complete actualisation, as opposed to merely *potential* existence. [ARISTOTELIAN PHILOSOPHY.]

Enteritis (Gr. ἔντερα, *the intestines*). Inflammation of the bowels. This disease may be occasioned by incautious exposure to cold, by acrid substances, or by hardened fæces in the bowels. Its symptoms are: pain over the abdomen; thirst, heat, and excessive restlessness and anxiety; sickness; obstinate constipation; and a hard, small and quick pulse. The pain increases as the disease proceeds, especially about

the navel; there is great difficulty in voiding the urine, which is small in quantity and high-coloured; and the abdomen is so tender as not to endure the slightest pressure. It often terminates in a few hours in mortification of a part of the intestinal canal; in which case the pain suddenly ceases, the belly becomes tumid, the pulse sinks rapidly, and the countenance acquires a peculiar ghastliness; it also proves fatal during the inflammatory stage. Favourable symptoms are: a gradual diminution of pain and of tenderness on pressure, natural evacuation by the bowels, moist skin, equal and firm pulse, and a copious discharge of urine depositing abundance of red sediment. This is a disease which requires prompt and decided treatment. Leeches should be applied over the abdomen, and the patient should be put in a hot bath, or fomented with hot water: the lower bowels should be evacuated by a glyster of castor oil and gruel, but purgatives should be avoided until inflammatory symptoms subside. Sickness should be quelled by the effervescing draught, with a very few drops of tincture of opium. In most cases small doses of calomel and opium have been given with great advantage. When the urgent symptoms give way, and the bowels have been cleared, diaphoretic saline medicines and gentle aperients may be used, and a mild nourishing diet allowed; but great care is requisite in ascertaining that all relics of the inflammatory action are got rid of, and that it is not lurking in some one spot in a chronic form, as enteritis is often the result of old disease existing in the cavity of the abdomen.

Enterocele (Gr. ἔντερα, and κήλη, *tumour*). A hernia or rupture, the contents of which are a portion of intestine.

Enterodela (Gr. ἔντερα, and δῆλος, *manifest*). The name given by Ehrenberg to a section of his class *Polygastrica*, comprehending those which have a complete alimentary canal terminated by a mouth and anus.

Enteroepiplocele (Gr. ἔντερα; ἐπίπλοον, *the omentum*; κήλη, *tumour*). A hernia or rupture containing both intestine and omentum.

Enterology (Gr.). A treatise on the bowels.

Enthymeme (Gr. ἐνθύμημα, *a thought*). In Logic, is commonly defined to be an argument having one premiss expressed, the other understood. [LOGIC; SYLLOGISM.] This is the character under which the universal form of reasoning, or syllogism, generally presents itself in connected writing. For example, the following argument, if drawn out in the correct logical form, would stand thus: 'All tyrants deserve death; but Cæsar is a tyrant, therefore Cæsar deserves death.' But in the rapid diction of oratory, or poetry, it would probably be expressed either, 'All tyrants deserve death, therefore so does Cæsar;' in which case the minor premiss, 'Cæsar is a tyrant,' is suppressed: or, 'Cæsar is a tyrant, therefore he deserves death,' by suppressing the major premiss. Instances may be cited in which the enthymeme consists merely of one of the premisses expressed, while both the other premiss and the conclusion are to be supplied by a rapid exercise of thought. Thus in the well-known words, 'But Brutus says he was ambitious, and Brutus is an honourable man,' the last of these propositions contains a complete argument: 'What honourable men say is to be believed: Brutus is an honourable man, therefore what Brutus says is to be believed.'

Entomology (Gr. ἔντομα, *insects*, and λόγος). The science of insects: the history of the organisation, habits, properties, and classification of those articulated animals which are distinguished by the presence of antennæ and of breathing organs, composed of ramified tracheæ with or without air-sacs. The name insect, from its etymological signification of an animal insected or divided into sections, is applicable to the greater part of the Articulate sub-kingdom, but is now restricted to the species characterised as above. The presence of highly developed organs for breathing air, together with peculiar and complex organs of sensation, is associated, as might be expected, with active powers of locomotion; and most insects, besides having articulated members for terrestrial progression, for leaping or climbing, swimming or diving, are endowed with wings, and are capable of rapid and extensive flight. The power of traversing space is given in greater fulness and perfection to the class of insects than to any other created beings on our planet. A peculiar condition of the breathing organs, and a peculiar animal tissue (chitine), which combines great strength, elasticity, and levity, coexist in insects, and in insects only.

Those insects which have more than six articulated legs, and have the segments of the trunk free, without distinction of thorax and abdomen, which undergo no other metamorphosis than acquiring an increased number of segments after exclusion from the egg, and which lastly possess neither compound eyes nor wings, are separated by some zoologists as a distinct class, under the name MYRIAPODA [which see].

In the Hexapod insects, the body is divided into a head, thorax, and abdomen; the head supports a pair of antennæ, and contains a pair of compound, and often also simple, eyes; the mouth is provided with a labium, labrum, mandibulæ, and maxillæ; the labium and maxillæ also support peculiar feeling organs, called *palpi*. Sometimes these parts of the mouth, which are termed collectively *trophi*, or oral organs, are distinct, and adapted to mastication: the insects thus characterised constitute an extensive primary division of the class termed *Mandibulata*. Those insects in which the trophi are so modified as to form an instrument of suction are included in the primary division called *Haustellata*.

The Hexapod insects were divided by Linnæus into the following orders:—

1. *Coleoptera*. Wings four, the upper pair hard, with a straight suture. Ex.: Beetles and earwigs.

2. *Hemiptera.* Wings four, the upper pair moderately hard and incumbent. Ex.: Bugs, locusts, tree-hoppers, plant-lice, &c.
3. *Lepidoptera.* Wings four, covered with scales. Ex.: Moths and butterflies.
4. *Neuroptera.* Wings four, membranaceous; anus unarmed. Ex.: Dragon-flies, May-flies, &c.
5. *Hymenoptera.* Wings four, membranaceous; anus aculeate. Ex.: Bees, ants, saw-flies, &c.
6. *Diptera.* Wings two; halteres two, in place of the posterior wings. Ex.: Flies.
7. *Aptera.* Wings none. In this order Linnæus included not only true Apterous insects, as fleas, but also centipedes, spiders, crabs, lobsters, &c.; or the articulate animals now forming the classes *Myriapoda*, *Arachnida*, and *Crustacea*.

There is not, perhaps, any class of the animal kingdom which has been the subject of more numerous and various attempts at classification than that of insects. We have just seen that Linnæus adopted the locomotive system as the basis of his method. Fabricius, his pupil, proposed a system founded on modifications of the structure of the mouth. Latreille endeavoured to form a natural classification of those most numerous animals from a consideration of their entire organisation. His latest system was as follows:—

Sub-class I. *Aptera.* No wings; simple eyes in most.

A. No metamorphosis, but simple moulting, without a season of torpidity; mouth in some a simple sucker, in others mandibulate.

Order 1. *Thysanura.*
2. *Anoploura* (or *Parasita*).

B. A complete metamorphosis, larvæ apodal; pupæ torpid; mouth haustellate, composed of an articulate sheath containing three setæ, with two scales at their base; body much compressed; the species saltatory and parasitic.

Order 3. *Aphaniptera* (or *Siphonaptera*).

Sub-class II. *Ptilota.* Wings, but sometimes not developed as such; two compound eyes, to which in many are added simple eyes.

A. Two wings covered by two elytra, either crustaceous or coriaceous.

a. Mandibles and maxillæ; elytra of the same consistence.

Order 4. *Coleoptera.*
5. *Dermaptera.*
6. *Orthoptera.*

b. No mandibles nor maxillæ; mouth haustellate, composed of an articulate sheath, including four setæ; elytra membranous at their extremity in most.

Order 7. *Hemiptera.*

B. Wings four or two; not covered by elytra.

a. Mandibulate; wings four, membranous, and generally transparent; a small scale (tegulum) at the base of the two anterior wings.

Order 8. *Neuroptera.*
9. *Hymenoptera.*

b. Haustellate; wings scaly; tegula large, and thrown back.

Order 10. *Lepidoptera.*

c. Two wings; haustellate.

Order 11. *Strepsiptera* (or *Rhipiptera*).
12. *Diptera.*

For the characters of the above orders, see the articles under their respective denominations.

Entomophaga (Gr. ἔντομα, and φάγω, *I eat*). A tribe of Marsupial quadrupeds, characterised by having three kinds of teeth—viz. incisors, canines, and molares—in both jaws, and the intestinal canal provided with a moderate-sized cæcum. The Opossums (*Didelphys*), Bandicoots (*Perameles*), and the genera *Myrmecobius* and *Chæropus* are associated to form this group; and feed principally, though not exclusively, on insects.

Entomostracans (Gr. ἔντομος, and ὄστρακον, *a shell*). A division of the class *Crustacea*, including those species which are covered with a thin horny tegument in the form of a shell, and consisting of one or two pieces.

Entophyte (Gr. ἐντός, *within*, and φυτόν, *a plant*). A plant which grows from within another, as some rhizanths, and fungi.

Entoyer (Fr.). In Heraldry, a bordure charged wholly with lifeless things.

Entozoa (Gr. ἐντός, *and* ζῶον, *an animal*). A name given to an extensive series of low-organised invertebrate and generally vermiform animals, of which the greater part are parasitic on the internal organs of other animals. They have colourless blood, circulated in the higher organised species in a closed system of vessels, without an auricle or ventricle; they have no respiratory organs, no articulated members for locomotion, no organs of sense. The digestive system consists either of tubes or cavities excavated in the parenchymatous texture of the body, and without an anal outlet; or of a tube with both oral and anal orifices freely suspended in an abdominal cavity. A filamentary nervous system has been recognised in the higher organised Entozoa, occasionally complicated with a ganglion near the mouth; the generative system is unisexual, hermaphrodite, or diœcious. (For the classification of the Entozoa, see Intestinalia.) The principal species of Entozoa known to infest the human body are the following: *Ascaris vermicularis*, *Ascaris lumbricoides*, *Trichocephalus dispar*, *Bothriocephalus latus*, *Tænia solium*, in the alimentary canal; *Distoma hepaticum*, in the gall-bladder; *Acephalocystis endogena*, *Echinococcus hominis*, in the substance of the liver, in the omentum and cavity of the abdomen; *Filaria bronchialis*, in the bronchial glands; *Strongylus gigas*, in the kidney; *Spiroptera hominis* and *Strongylus spiniger*, in the urinary bladder; *Polystoma pinguicola*, in the ovarium; *Trichina spiralis*, in the voluntary muscles; *Cysticercus cellulosæ*, *Filaria medinensis*, and *Filaria oculi*, in the cellular tissue. The above

is not a complete list, and the recent labours of Spencer Cobbold and other entozoologists have greatly increased our knowledge of the parasites infesting man.

Entrepôt (Fr. from Lat. interpositum, *placed between*). In Commerce, the name given in France and some other countries to a warehouse or other place where goods brought from abroad may be deposited, and whence they may be withdrawn for export to another country, without payment of any tax or duty. An entrepôt is, therefore, synonymous with what is called a *free port* on the Continent, and in this country with a *bonded warehouse*, that is a warehouse in which foreign products are stored under the joint locks of the king and the importer: if such products be entered for home consumption, they are free of duty till their entry; and if they be re-exported to a foreign country, they are exempted from all duty, and merely pay a small sum as warehouse rent. In popular and less correct language, the word *entrepôt* is frequently employed to designate a seaport or commercial town which exports the produce of a considerable adjacent territory, and imports the foreign articles required for its supply.

Entresol (Fr.). In Architecture. [MEZZANINE.]

Entrochite (Gr. ἐν, *in*; τρόχος, *a wheel*). A genus of fossils consisting of the petrified arms of the sea starfish.

Entropium (Gr. ἐν; τρέπειν, *to turn*). A turning in of the eyelashes and eyelid, so as to irritate the ball of the eye.

Entry. In Law, the taking possession of lands and tenements where a man has title of entry. The term is also used for a writ of possession. Entry is either actual, made by the party or his attorney; or an entry in law, by continual claim. Remedy by entry takes place in cases of abatement, intrusion, and disseisin: not on discontinuance or deforcement.

Enurney. In Heraldry, a bordure charged with wild beasts.

Envelopes. In Geometry, curves or surfaces which are generated by the repeated intersections of given curves or surfaces whose position, form, and magnitude are allowed to vary according to some continuous law. Thus a tubular surface is the envelope of a moving sphere of constant radius, a plane curve is the envelope of its tangent, and the reciprocal of a curve is the envelope of the polar $xx_1+yy_1+zz_1=0$, of one of its points $(x_1y_1z_1)$ with respect to the circle $x^2+y^2+z^2=0$.

If in the equation $u=0$ of any curve of the n^{th} order the coefficients of x and y involve any parameter a, then as the latter varies continuously, the position, form, and magnitude of the curve will in general change; when this value is increased by h, for instance, the curve will have the equation

$$u+\frac{du}{da}h+\frac{d^2u}{da^2}\frac{h^2}{1.2}+\&c.\ldots=0,$$

or simply $$u+\frac{du}{da}h=0$$

if the variation of a be infinitesimal. From the last and the original equation $u=0$, therefore, we shall be able to express the coordinates of the points in which any curve intersects its consecutive, in terms of the parameter a which individualises that curve. The two equations referred to, however, are perfectly represented by the system

$$u=0,\ \frac{du}{da}=0,$$

from which, by eliminating a, we may clearly obtain the Cartesian equation of the envelope. Hence, the equation of the envelope results from equating to zero the discriminant of u, relative to a. If a should enter into the function u in the m^{th} degree, this discriminant will involve the coefficients of a in the degree $2(m-1)$; but these coefficients being, by hypothesis, functions of x and y of the degree n, the envelope will in general be a curve of the $2n(m-1)^{th}$ order. Again, through any point in the plane will in general pass m of the enveloped curves u, since on substituting in $u=0$ the coordinates of such a point we shall have an equation of the m^{th} degree in a, the roots of which will individualise m curves u passing through the point. On this account the curves to which u belongs are said by E. de Jonquières to form a system of the order n and *index* m. (Liouville's *Journal*, 1861.) Thus if the system of curves u form a pencil, then $m=1$ and the envelope will be of the order 0, in other words will degenerate to the system of n^2 points through which all curves of the pencil pass. On the other hand, if $u=0$ represent a system of right lines, then $n=1$ and the envelope will be of the $2(m-1)^{th}$ order and m^{th} class. In the latter case it may also be observed that three consecutive tangents will intersect in the same point, in other words the envelope will have a cusp or stationary point, whenever

$$u=0,\ \frac{du}{da}=0,\ \frac{d^2u}{da^2}=0.$$

Eliminating x and y from these three equations, therefore, the resulting equation will have for its roots those values of a which belong to cuspidal tangents. This resultant equation in a being, by the theory of elimination, of the $3(m-2)^{th}$ degree in a, we conclude that the envelope has, in general, $3(m-2)$ cusps. According to Plücker's equations, therefore [SINGULARITIES OF CURVES], it must also have $2(m-2)(m-3)$ double points, and $\frac{1}{2}(m-1)(m-2)$ double tangents, but no points of inflexion.

The same method is pursued in surfaces. If $u=0$ represent the enveloped or generating surface, the consecutive one will intersect it in the curve

$$u=0,\quad \frac{du}{da}=0,$$

and the *locus* of this curve, or *characteristic* as it has been called by Monge (*Application de l'Analyse à la Géométrie*), will be the *envelope*. [CHARACTERISTIC.] Its equation of course

results from the elimination of a from the last two equations. The intersection of this characteristic by the next following one is represented by the equations

$$u=0,\ \frac{du}{da}=0,\ \frac{d^2u}{da^2}=0,$$

from which if a be eliminated, the equation of the *cuspidal edge* of the envelope will be obtained; a curve on the latter which separates its two sheets. A cusp or stationary point on this cuspidal edge will be represented by the three equations in x, y, z which result from the elimination of a from

$$u=0,\ \frac{du}{da}=0,\ \frac{d^2u}{da^2}=0,\ \frac{d^3u}{da^3}=0.$$

When $u=0$ represents a plane, the characteristic will be a right line, and the envelope a developable surface. If, besides being a linear function of x, y, z, u is also a rational function of a of the degree m, then the developable will be of the m^{th} class and $2(m-1)^{\text{th}}$ order, exactly as in the case of curves. The other singularities of the envelope may be easily ascertained. (Salmon's *Analytical Geometry of Three Dimensions.*)

Envoys, Ordinary and Extraordinary. Diplomatic ministers of the second order are so called. [AMBASSADOR.]

Enyo (Gr. Ἐνυώ). In Greek Mythology, a goddess who accompanies ARES [which see] in battle, and delights in havoc and bloodshed. In Hesiod. (*Theog.* 273) Enyo is one of the Graiæ, or daughters of Phorcus and Kêto. [BELLONA.]

Eocene. In Geology, one of the divisions of the tertiary period, originally suggested by the occurrence in the older tertiary rocks, so called, of a few faint dawnings of existing species of fossils (Gr. ἠώς, *dawn*; καινός, *recent*). The term was originally limited by the percentage ($3\frac{1}{2}$) of recent to extinct species found in a large collection of older tertiary shells of the Paris Basin, and had reference to other terms of the same kind, namely MIOCENE and PLEIOCENE. Although there are now many divisions not originally contemplated, and the percentage system is practically abandoned in the sense first intended, the terms are retained by most English and many foreign geologists. The subdivisions of the lower tertiary deposit are into UPPER, MIDDLE, and LOWER EOCENE [which see].

The eocene rocks generally are well developed in the neighbourhood of the three principal capitals of Western Europe: London, Paris, and Brussels. Each of these is, in fact, built on a special tertiary basin of this period. The rocks have thus attracted much attention; and their interest is the greater as they contain varied and interesting groups of fossils of all kinds, from the monkey down to the most minute foraminifer. The climate and arrangement of the land in the northern hemisphere must have been very different during the eocene period from that which has prevailed since.

Eolipile. [ÆOLIPILE.]

Eos (Gr. ἠώς, *morning*). In Greek Mythology, a daughter of Hyperion, and wife of Tithonus. The myths about Eos explain themselves. Her mother is Euryphassa, *the broad-shining*, as Telephassa, the *far-shining*, is the mother of Europa: she is a sister of Helios and Selene, the sun and the moon; and the horses which draw her chariot are Lampus and Phaethon, the *bright* and *glistering*. In the myth of Kephalos, she is jealous of Procris, *the Dew*, and causes her death. When her son Memnon is killed, her tears fell from the sky in the form of morning dew. [AURORA.]

Epacridaceæ (Epacris, one of the genera). A natural order of shrubby Exogens, for the most part natives of Australia. They differ from *Ericaceæ* chiefly in the structure of the anther, which is one-celled and destitute of appendages. The fruit of *Lissanthe sapida*, and a few other species, is eaten under the name of the Australian Cranberry; otherwise there is no plant of any known use in the order, which, however, contains many beautiful species of the genera *Epacris*, *Lysinema*, *Sphenotoma*, *Styphelia*, and *Dracophyllum*.

Epact (Gr. ἐπακτός, *added or introduced*). In Chronology, this term denotes the moon's age at the end of the year, or the number of days by which the last new moon has preceded the beginning of the year. The common solar year consists of 365 days, and the lunar year of only 354 days: the difference is therefore 11; whence, if a new moon fall on the 1st of January in any year, the moon will be 11 days old on the 1st day of the following year, and 22 days old on the 1st of the third year. The numbers 11 and 22 are therefore the *epacts* of those years respectively. The addition of 11 to the last epact gives 33 for that of the succeeding or fourth year; but as the lunar month never exceeds 30 days, the epact cannot exceed 30; whence 30 is deducted from 33, and the epact is reduced to 3. Of the thirty days thus rejected an *embolismic* or *intercalary* month is formed, which, consequently, occurs every third year of the lunar cycle, and gives 13 lunar months to that year. In like manner the epacts of all the succeeding years of the lunar cycle are obtained; that is to say, by adding successively 11 to the epact of the former year, and rejecting 30 as often as the sum exceeds that number, the leap years being taken account of by adding one day to each lunar month which contains the 29th of February. Supposing, therefore, the epact of the first year of the cycle to be 11, the epacts of all the 19 years of which the cycle is composed will be as follows: 11, 22, 3, 14, 25, 6, 17, 28, 9, 20, 1, 12, 23, 4, 15, 26, 7, 18, 29. But the order is interrupted at the end of the cycle; for the epact of the following year, formed in the same manner, would be $29+11-30=10$, whereas it ought obviously to be 11, to correspond with the moon's age, all the circumstances being now supposed to be the same as they were at the commencement of the previous cycle. In

order to understand this, it is necessary to remember that the lunar cycle of the ecclesiastical calendar is composed in the following manner: The lunations are supposed to consist of 29 and 30 days alternately, or the common lunar year of 354 days; and, in order to make up 19 solar years, six embolismic or intercalary months of 30 days each are inserted in the course of the cycle, and one of 29 days at the end. Hence it follows that after adding 11 to the epact of the 19th year of the cycle, we must reject 29 instead of 30, in order to have the epact of the following year, or the first year of the following cycle.

This method of forming the epacts is adapted to the Julian calendar, and might be continued indefinitely, if the Julian intercalation were followed without interruption, and the lunar cycle, defined as above, had corresponded exactly with the lunar motions. But the intercalation is subject to correction, and the cycle is not quite exact. Hence the epacts must occasionally be adjusted; and, generally speaking, an alteration is made on the last year of each century. In the ordinary tables of the church calendar the epacts are therefore given only for a single century; but as the Gregorian calendar now in use defines precisely the length of the year, tables, though somewhat more complicated, have been formed, which show the epacts of every future year in all time to come. They may even be found by means of an algebraic formula of no great perplexity. (See the article 'Calendar' in the *Encyclopædia Britannica.*) The epacts were invented by Luigi Lilio Ghiraldi, more frequently styled Aloysius Lilius, a physician of Naples, and author of the Gregorian calendar, for the purpose of showing the days of the new moons, and thence the moon's age on any day of the year, and consequently of regulating the church festivals. It is only in ecclesiastical computations that the epacts are ever employed; in civil affairs the civilised portion of mankind have long since laid aside the use of the lunisolar year, and regulated time entirely by the sun. In the calendar of the church of England, Easter and the other movable feasts are determined in the same manner as in the old Romish calendar, excepting that the golden numbers are prefixed to the days of the *full moons*, instead of the days of the new moons. The epacts are consequently not used. It is desirable that the custom of reckoning time by the moon, which had its origin in ignorant ages, were abandoned, and the civil year adopted for every purpose. [CALENDAR.]

The following table shows the epacts corresponding to each year of the lunar cycle during the present century. The year of the cycle is what is usually called the golden number, which is found by the following rule: Add 1 to the date (or year), and divide the sum by 19; the quotient will be the number of cycles elapsed since the commencement of the era, and the remainder the golden number. [GOLDEN NUMBER.]

Table of Gregorian Epacts.

Golden Number	Epact	Golden Number	Epact	Golden Number	Epact
I.	0	VIII.	17	XV.	4
II.	11	IX.	28	XVI.	15
III.	22	X.	9	XVII.	26
IV.	3	XI.	20	XVIII.	7
V.	14	XII.	1	XIX.	18
VI.	25	XIII.	12	I.	0
VII.	6	XIV.	23		

Epagoge. [INDUCTION.]

Epaulement (Fr.). The shoulder or short parapet made at the flank of a battery, or extremity of a parallel, to prevent its being enfiladed.

Epaulettes (Fr.). Distinguishing ornaments worn on the shoulders by officers. In the different armies of the German states ensigns are not allowed to wear epaulettes; and hence the phrase *to obtain epaulettes* is synonymous with *to become a lieutenant.* Epaulettes were worn by officers of the British army until 1855. They are still worn in the navy, by the gentlemen-at-arms, and by deputy-lieutenants.

Epencephalic Arch (Gr. ἐπί, *upon*, ἐγκέφαλον, *the brain*). The bony arch which encompasses and protects the epencephalon: it is composed of the basioccipital, exoccipitals and superoccipitals, and, in general anatomy, forms the neural arch of the occipital vertebra.

Epencephalon. In Anatomy, the hindmost of the four primary divisions or segments of the brain, including the medulla oblongata, pons varolii, cerebellum, and fourth ventricle.

Epenetic (Gr. ἐπαινετικός, from ἔπαινος, an *encomium*). The laudatory or encomiastic species of oratory: a branch of the Epideictic, according to the division of Aristotle *De Rhetorica.* [PANEGYRIC.]

Epenthesis (Gr.). A figure of Grammar, by which one or more letters are inserted in the middle of a word; as in the Latin *rettulit* for *retulit.* [METAPLASM.]

Eperua (the name of the fruit in Guiana is eperu, *a sabre*). A genus of *Leguminosæ*, one species of which, *E. falcata*, the Wallaba, is very abundant in the forests of Guiana, where it yields a hard coarse-grained timber of a bright red-brown colour, which splits so readily that it is much used for shingles, and being charged with resin is very durable.

Ephah or **Epha.** A Hebrew measure of weight and capacity, containing 27·83 pints or pounds.

Ephebi (Gr. ἔφηβοι, *arrived at puberty*). A name applied particularly to the Athenian youth between the ages of eighteen and twenty years.

Ephelis (Gr. ἐπί, *upon*, and ἥλιος, *the sun*). Spots seen upon the skin varying in colour from yellow and light brown to nearly black. Ordinary freckles are included under this head.

The spots and markings occasioned by approximating the legs and hands too closely to the fire, go by the name of *ephelis ab igne*, and older pathologists have probably applied the term to *colourations* of the skin which are now recognised as concomitants of a grave form of disease, *morbus Addisoni*.

Ephemerans, Ephemerinae (Gr. ἐφήμερος, *lasting for a day*). A family of Neuropterous insects, having the genus *Ephemera* as a type. They are called *dayflies*, from the enjoyment of their last stage of existence being generally limited to twenty-four hours.

Ephemeris (Gr. ἐφημερίς, *a diary*). An astronomical table showing beforehand the places of a celestial body. Ephemerides (the plural) of the sun, moon, stars, and planets are computed and published annually. The most celebrated of these are our own *Nautical Almanac*, the French *Connaissance des Temps*, and the Berlin *Jahrbuch*. The *Nautical Almanac* for 1868 has already appeared (June 1865).

EPHEMERIS. In Literature, a collective name for reviews, magazines, and all kinds of periodical literature.

Ephialtes (Gr. literally *one who leaps upon* anything). The nightmare. This affection, consisting of horrid dreams, with a sensation of great pressure upon the body, and of fruitless endeavours to escape and call for help, is generally symptomatic of indigestion, or of overdistension of the stomach. For its relief, opening medicine, and sometimes an emetic, are often required, and careful abstinence from all that promotes dyspepsia, especially suppereating.

Ephod (Heb.). An ornament worn by the Hebrew priests. That of the high priest was composed of gold, blue, purple, crimson, and twisted cotton; on the part which came over his shoulders were two large precious stones, on which were engraven the names of the twelve tribes of Israel, six on each stone. The ephods worn by the ordinary priests were of fine linen.

Ephori (Gr. ἔφοροι). In Ancient History, the title of a class of magistrates common to many of the Dorian states of Greece, but more particularly known in reference to the political constitution of Sparta, where the ephors held the supreme power in the state. The Spartan ephors were five in number, and were elected annually from the body of the ruling caste, and not from any particular tribe. Besides their judicial authority, they exercised a control over the functions of the kings and the senate, and sometimes recalled the former from their foreign expeditions, and demanded an account of their proceedings. The executive power likewise was almost wholly in their hands.

Epic (Gr. ἔπος, *a word* or *tale*). If a name, which has been loosely applied to poems differing widely from each other in many important features, admits of definition, an epic may be defined to be a poem which relates the history of some one event or one series of events which, apart from what precedes or follows them, may be regarded as a whole. But it may fairly be doubted whether any idea of such unity of conception or execution was present to the minds of the poets under whose hands the earliest epic poems grew up into shape. Every race or tribe has had its legends or myths; but not all tribes have seized on some one or more of its prominent myths, and moulded them into long narrative poems, like those of the Hindus, the Greeks and the Teutons.

Of the Greek epics, two only, the *Iliad* and the *Odyssey*, have come down to us: yet in the eighth century before the Christian era there existed a large number, among which may be named the *Capture of Œchalia*, the *Return of the Heroes from Troy*, the *Epigoni*, the *Æthiopis* of Arctinus, &c. On these poems, Mr. Grote (*History of Greece*, part i. ch. xx.) remarks that, though they served as food for the curious, and as storehouses for logographers, tragedians and artists, they 'never seem to have acquired very wide popularity even among intellectual Greeks.' If it is not easy to account fully for so singular and significant a fact, we may at least note the difference between epic poems whose date and authorship are unknown, and epics which have proceeded from some one author in an historical age. A vast gulf separates the Homeric poems from the *Æneid* of Virgil. As compared with the *Iliad* or the *Odyssey*, the construction of the *Æneid* is artificial, and throughout the poet is seen executing a self-imposed and a somewhat laborious task. In the former there is no appearance of effort, while there seems to be an overwhelming amount of evidence to show that the two poems could not have been the work of any one man. If the greater unity of the *Odyssey* may be taken as proving that a single poet has cast the tale into its present shape, the *Iliad* in strictness of speech exhibits no unity at all. It is popularly supposed to relate the tale of the Trojan war; in reality it professes to speak only of the wrath of Achilles and its results, and it does not fulfil even this promise. (*Edinburgh Review*, January 1865, p. 137 &c.) As Mr. Grote has shown, the first book belongs to a poem which was an *Achilleis*; the second book belongs properly to an *Iliad*; and thenceforth the two poems are put together by a process of dovetailing which is not always free from clumsiness. But the whole action of the *Iliad* is only a single episode in the tale of Troy; and the tale of Troy itself, in Professor Max Müller's belief, 'is but a repetition of the daily siege of the East by the solar powers, that every evening are robbed of their brightest treasures in the West.' Thus much at least is clear, that, although for the Greek these poems had, in Mr. Grote's words, the 'weight and solemnity of history and religion combined,' they are for us utterly unhistorical. After a careful examination, Mr. Grote deliberately concludes that 'as the possibility of an historical Trojan war cannot be denied, so neither can the reality of it be affirmed.' But the improbability of the former is enormously increased when we find that a marvellous pa-

rallelism runs through the great epic poems of Greece, India, and Germany; that the *Odyssey* reproduces the main incidents of the *Iliad*; and that these, with many names, phrases, and turns of thought, are to be found also in the Vedic poems, as well as in the Saga of the Volsungs, and the Lay of the Nibelungs. Without going, therefore, at length into the vexed question of the composition of the Homeric poems, thus much may be affirmed without fear of contradiction, that they were composed in an age which had no contemporary history; that they were not reduced to writing until long after they had been composed; and that they comprise narratives many of which may, and some of which, it would seem, must, have existed once as separate poems. From this the conclusion seems to follow that a real epic is the expression of national thought, working on materials common to the whole Aryan family of nations, and possibly not wholly confined to these. Hence there would appear to be a close and inseparable connection between epic poetry and mythology. The epic is the genuine growth of a mythopœic age; while the so-called epics of historical periods are either mere imitations, or poems which have an epical character chiefly or only as narrating a real or alleged history. The latter may exhibit the genius of a single poet; the former are of the highest importance as throwing light on many stages in the history of the human mind, for which they furnish the only evidence. To the former class belong the great poems of Milton, Tasso and Dante. The Spanish *Romance of the Cid* approaches nearer to the character of the *Nibelungen Lied*, and seems to exhibit some of the intermediate phases through which the *Iliad* passed before it was brought into its present shape. The French epics, as the *Henriade* of Voltaire, &c., are more thoroughly artificial than the other poems of modern times which have been entitled *epics*.

The Finnish epic of Wainamoinen is based on cosmogonical myths, which in Greece found their expression in the Orphic and Hesiodic theogonies.

Epicalyx (Gr. ἐπί, and κάλυξ, *a flower-cup*). In Botany, the involucallum or series of envelopes external to the calyx, such as occur in *Malva*.

Epicanthis (Gr.). In Anatomy, the angle of the eye.

Epicaridans, Epicarides (Gr. ἐπί, *upon*, and καρίς, *a shrimp*). A family of Isopodous or equal-footed Crustaceans, which are parasitic upon shrimps.

Epicarp (Gr. ἐπί, *on*, and καρπός, *fruit*). In Botany, the outermost layer of the pericarp.

Epicedium (Gr. ἐπικήδειον, from ἐπί, and κῆδος, *grief*). In Poetry, an elegiac poem on the occasion of a funeral solemnity in honour of some deceased person.

Epicene (Gr. ἐπίκοινος, *common*). In Grammar, a name used to designate those nouns which may be applied to objects masculine and feminine indifferently.

Epicranitis (Gr.). In Ancient Architecture, a tile forming the cyma of the cornice. The term is used in a celebrated Athenian inscription brought to this country by Dr. Chandler, and now in the British Museum.

Epicureans. Followers of the tenets of Epicurus, a philosopher who lived from B.C. 337 to B.C. 270, and taught during the latter half of his life at Athens. The name of Epicureans has become the general designation of those who, either theoretically or practically, make pleasure the chief end of life and the standard of all virtue. Epicurus was the first philosophical teacher who deserted the lofty idea of science which Plato and Aristotle had striven to develope. Truth is, with him, no longer an object worth pursuing for its own sake, but only in so far as it contributes to the peace of mind of its possessor. Hence, though he retains the threefold division of philosophy into ethics, physics, and dialectics (in Epicurean language, *canonic*), he assigns the two latter a place subordinate to the first, and bestows on them a mere cursory treatment. But we should greatly wrong Epicurus if we represented the gratification of the sensual appetites to be the object proposed by him to the wise man. The happiness which he regards as the true end of existence is rather a species of quietism, in which the philosopher, protected by his knowledge from all fear of injury from the powers of nature, and by the laws from the assaults of his fellow-creatures, holds himself open to all the pleasurable sensations which the temperate indulgence of his ordinary appetites, the recollection of past enjoyments, and the anticipation of future, are sufficient abundantly to furnish. In order to support his imaginary wise man in this tranquillity, he deemed it necessary to show that the apprehensions which beset mankind, of death, of the power and anger of the gods, and the like, are wholly unfounded. For this purpose he made use of the physical doctrine of Democritus; a system of atomic materialism, which makes all existences to arise from the concourse of minute particles of matter—the soul among the number, which is consequently, at the moment of death, resolved into its constituent elements. The mental philosophy of Epicurus was of a similar stamp: all our mental powers are resolved into sensation, immediate or recollected; and sensation, under both its forms, consists in the influx of certain extremely fine films, which are perpetually, as it were, sloughed from external objects, and find their way through the organs of sense to the soul. The gods of the Epicureans bear no relation to any part of their system: they are beings sprung, like men, from the concourse of atoms, and differing from them only in their superior blessedness and tranquillity, shown in their entire separation from the care and government of the world. The followers of Epicurus were numerous, especially among the Romans. Little more, however, than their names are recorded; with the exception of Lucretius, who, in his well-known poem, *De Rerum Naturâ*, illus-

trates and defends the physical and religious tenets of his master. In modern times, Gassendi, an atomic philosopher of the seventeenth century, has published an able statement of the Epicurean system, under the title of *Syntagma Philosophica Epicuri.* (See also Diogenes Laërtius, *Vit. Phil.* l. x.; and Cicero's philosophical writings generally: also Ritter, *Gesch. der Philos.* b. x.: and for a list of the Epicureans, *Fabricii Bibliotheca Græca*, vol. iii. ed. Harles.)

Epicycle (Gr. ἐπί, *upon*, and κύκλος, *circle*). In the Ancient Astronomy, a circle having its centre on the circumference of another circle. It was a favourite axiom of the Greek astronomers, that all the celestial motions must be circular and uniform. The phenomena of the stations and retrogradations of the planets were apparently inconsistent with this supposition; and in order to explain them, Apollonius of Perga imagined the ingenious apparatus of *epicycles* and *deferents*. He supposed the

planet P to move uniformly in the small circle or *epicycle* P A B, the centre of which is carried uniformly forward along the circumference of the large circle or *deferent* C D F, of which the earth occupies the centre E. Hipparchus, having discovered the eccentricity of the solar orbit, supposed the motions to be performed in eccentric circles. Ptolemy, the celebrated founder of the system which astronomers followed till the days of Copernicus, adopted the hypotheses both of Apollonius and Hipparchus; that is, he supposed the earth E to be placed at a small distance from the centre of the deferent circle (which consequently was called an *eccentric*), and the planet to move uniformly in the epicycle, the centre of which also moves uniformly in the deferent. By means of these suppositions, and by assigning proper ratios (determined by observation) between the radius of the deferent and the radius of the epicycle, and also between the velocity of the planet in its epicycle and the velocity of the centre of the epicycle on the deferent, he was enabled to represent with considerable accuracy, indeed with all the accuracy which the observations of that time required, the apparent motions of the planets, and particularly the stations and retrogradations which formed the principal object of the researches of the ancient astronomers. As a first step towards connecting the two sciences of astronomy and geometry, the system of epicycles does infinite honour to its inventors; and it ought to be borne in mind that it was never given out by Ptolemy as anything else than a mere hypothesis for representing the apparent celestial motions, or, as he expresses it, for *saving* the appearances.

Epicycloid. The curve traced by a point on the circumference of a circle which rolls on the convex side of a given fixed circle. The epicycloid belongs to the large family of curves known as *roulettes*; it is not necessarily a transcendental curve; in fact it is always of finite order, when the circumferences of the two circles are commensurable. The normal of the epicycloid may be easily constructed; it always coincides with the line which joins the generating point to the corresponding point of contact of the two circles. The evolute of the epicycloid is a similar epicycloid, the radii of the circles being merely altered in a certain ratio. When the circles are equal, the epicycloid is similar and similarly placed to the pedal of the fixed circle with respect to a point in the circumference. [PEDAL.] The curve is in fact the cardioid which is the inverse of a parabola. The equations of epicycloids are easily found, and are given in all text-books.

The epicycloid was invented by the celebrated Danish astronomer Romer, the discoverer of the progressive motion of light, who proposed this curve, about the year 1674, as the proper form of the teeth of wheels, in order to destroy the friction. Newton, in the first edition of the *Principia*, gave its rectification; and Halley, in the *Philosophical Transactions*, No. 218, showed how its quadrature depends on that of the generating circle. The other principal properties of the curve were discovered and demonstrated by John Bernouilli.

Epidemic (Gr. ἐπιδήμιος, *among the people*). An infectious or contagious disease, which attacks many people at the same period and in the same country, 'rages for a certain time, and then gradually diminishes and disappears, to return again at periods more or less remote.' Thus Asiatic cholera, influenza, scarlet fever, measles, &c., frequently appear as *epidemics*; that is, are found to prevail in certain parts of a country, while the adjacent districts are free from their ravages. It is essential to the medical notion of an *epidemic* that it be of a temporary, in contradistinction to a permanent character, though isolated cases may occasionally be observed in districts once visited by the epidemic. It differs from *endemic*, inasmuch as the latter class of diseases are of a more permanent nature, and prevail only among certain people and in certain districts.

Epidermic Method. The application of medicinal substances to the skin, such as baths and lotions. But the term is more generally used in reference to the affection of remote parts of the system by external applications, aided by friction, and to this the term *iatroleptic method* (from the Greek ἰατρεύω, *to cure*, and ἀλείφω, *to anoint*) has been especially applied. In this way mercurial ointment is frequently employed; and opium, belladonna, iodine, and some other powerful remedies have been similarly used.

Epidermis (Gr. *the outer skin*). In Anatomy, the cuticle or scarf skin. It is an albuminous membrane.

EPIDERMIS. In Botany, the cellular integument, or the exterior cellular coating of the bark, or leaf, or stem of a plant. It is composed of cells compacted together into a stratum, varying in thickness in different species, and is often readily separable by gentle violence.

Epididymis (Gr. *ἐπιδιδυμίς*). In Anatomy, a body formed by convolutions of the commencement of the sperm-duct or *vas deferens*, lying upon the testicle, and more or less closely attached to that gland.

Epidote (Gr. *ἐπίδοσις, increase*; because the base of the primary form undergoes an increase in some of the secondary forms). A mineral which has received several names. It consists essentially of silicate of alumina with silicate of lime (*Zoisite* or calcareous Epidote), or with silicates of lime and of protoxide of iron (*Pistacite* or calcareo-ferruginous Epidote), or with silicates of lime and of protoxide of iron and manganese (Manganesian Epidote). Its colour is usually various shades of green, yellow and red. It occurs in granite and other igneous rocks, and in various crystalline slates.

Epigæous (Gr. *ἐπίγαιος, on the earth*). In Botany, a term used to denote plants which grow close to the earth.

Epigastric Region (Gr. *ἐπιγάστριον*, from *γαστήρ, the stomach*). That part of the abdomen which is over the stomach. It is also called the *epigastrium*.

Epigenesis. In Physiology. [EVOLUTION.]

Epiglottis (Gr. from *ἐπί*, and *γλῶττα, the tongue*). An oval cartilage at the root of the tongue, which closes upon the superior opening of the larynx; its upper extremity is loose, and elevated by its own elasticity: it closes the aperture of the larynx when the tongue is drawn back in the act of deglutition. Its base has a ligamentous attachment to the base of the tongue, the thyroid cartilage, and the os hyoides.

Epigoni (Gr. *ἐπίγονοι, the after-born*). The collective appellation of the sons of the seven Greek princes who conducted the first mythical war against Thebes without success.

Epigram (Gr. *ἐπίγραμμα, an inscription*). In Poetry, a short poem or piece in verse, which has only one subject, and finishes by a witty or ingenious turn of thought; or, to use a more general definition, an interesting thought represented happily in a few words.

The first of these definitions, although tolerably correct as to the modern epigram, differs, as it will be seen, widely from the original sense of the word in Greek. The Greek epigram was, in the first instance, a short collection of lines actually inscribed on a monument, statue, fountain, &c.; and the word was thence transferred to such short poems as might serve for inscriptions: of such the collection termed the *Greek Epigrams* is almost wholly composed. Their general characteristic is perfect simplicity, and the seemingly studied absence of that *point* which characterises the modern epigram. But probably this seeming pointlessness is due to our ignorance of the full circumstances under which they were written, and to which they make reference or allusion. Many modern epigrams which appear excessively harsh and bitter would certainly have been dull and flat to Cicero or Cæsar, from mere ignorance of the double play of thought which gives point to words seemingly colourless. Hence it would seem that the first and the indispensable requirement of an epigram is not brevity, or sharpness, or honey (which are secondary and subordinate attributes), but *antithesis*. The more sudden the blow, the more striking is the epigram; hence the epigram which is confined to the couplet makes the nearest approach to perfection of its kind. Epigrams are almost wholly in one form of metre, the elegiac.

In the poetry of classical Rome, the term *epigram* was still somewhat indiscriminately used to designate short pieces in verse; but the works of Catullus, and still more the well-known collection of the *Epigrams of Martial*, contain a great number which present the modern epigrammatic character; and Martial has, in fact, afforded the model on which the modern epigram has been framed. In this class of composition, and especially where the turn of thought is satirical, the French writers have been far more successful than those of any other nation; and the term *piquant* seems expressly invented to designate the peculiar force of those epigrammatic sallies of fancy of which their literature is full.

Epigraph (Gr. *ἐπιγραφή, an inscription*). Also termed *Motto*. In Literature, a citation from some author, or a sentence framed for the purpose, placed at the commencement of a work or of its separate divisions.

Epigynous (Gr. *ἐπί*, and *γυνή, a female*). A term used in Botany to denote any organ growing upon the summit of the ovary. It is employed to express the condition of the outer whorls of the flowers, when they adhere to the ovary, so that the outer parts alone are free, and appear seated on it, as in *Umbellifers*, *Campanulas*, &c.

Epilepsy (Gr. *ἐπίληψις, a seizure*). This disease is also called the *falling sickness*, from the suddenness of its attack. The *morbus comitialis* of the ancient Romans was doubtless epilepsy. It is attended by convulsive stupor and frothing at the mouth. It comes on by fits, which after lasting a certain time go off, generally leaving a degree of lassitude and drowsiness. Where fits are symptomatic of irritation in the primæ viæ, from worms, or indigestible and noxious food, or poisons, or when they arise from the suppression of long-accustomed evacuations, the treatment is sufficiently obvious; so also in cases where they result from a blow, wound, or fracture, or from diseased bone, they may be relieved by proper surgical aid. True epilepsy, however, is always indicative of something essentially wrong in the nervous system; and where it arises from hereditary disposition, or comes on about the age of puberty, where the fits are frequent, and cannot be referred to any apparent cause, an unfavourable opinion must be formed respecting its termination, which, if not in apoplexy, is commonly in mental alienation or imbecility. Yet the most unpromising cases have in a few rare instances ended well; that is, they have not recurred after violent pains

or eruptive disorders. It sometimes happens that certain symptoms precede the attack; and among them a sense of coldness proceeding from some part of the body towards the head and called *aura epileptica*, with palpitation, flatulency, and slight stupor, are the most common. In such cases a brisk emetic, a large dose of opium and ether, a cold bath where it may be ventured upon, or anything which produces a sudden shock upon the system, has prevented the fit. The most effective remedial treatment seems to be that which is directed to the diminution of nervous irritability by tonics. Bark, quinia, cascarilla, valerian, and some metallic salts, such as sulphate of iron, zinc, or copper, arsenate of potash, or the arsenical solution, and especially nitrate of silver, may be used; but the chance of permanently disfiguring the patient by the leaden hue which this last salt often communicates to the skin, should induce practitioners to be most scrupulous in the selection of this remedy. It is said that a violent scald or burn, or great alarm, as from a fire, a fall, or other accidents, have sometimes relieved the system of this complaint; and hence perhaps the superstitious notions which have attached to its cure by charms.

During an epileptic fit, nothing can be done for the relief of the sufferer except taking care that he does not injure himself, and relieving him of any part of his dress which may tend to compress the vessels of the head; the paroxysms, however, very frequently occur in the night.

Epilogue (Gr. ἐπίλογος). In Dramatic Poetry, the closing address to the audience at the end of a play.

Epimeral (Gr. ἐπί, and μηρός, *a thigh*). In Zoology, the part of the segment of an articulate animal which is above the joint of the limb.

Epimetheus. [PROMETHEUS.]

Epiphany (Gr. ἐπιφάνεια). A church festival, signifying the manifestation of Christ, and referring to the appearance of the star which announced His birth to the Gentiles. It is observed on January 6, the twelfth day from Christmas.

Epiphora (Gr. from ἐπί, and φέρω, *I bear*). A disease occasioned by a superabundant secretion of tears.

Epiphyllous (Gr. ἐπί, and φύλλον, *a leaf*). In Botany, something inserted upon a leaf.

Epiphysis (Gr. ἐπίφυσις, *an outgrowth*). A process of a bone separated at first by a layer of cartilage from that to which it is attached.

Epiphyte (Gr. ἐπί, *on*, and φύω, *I produce*). A plant which finds a resting-place upon the surface of other plants, e.g. many mosses and orchids, as distinguished from parasites which draw sustenance from their foster plants.

Epiplocele (Gr. ἐπίπλοον, *the omentum*, and κήλη, *tumour*). A hernia or rupture formed by a protrusion of the omentum.

Epiploon (Gr.). The OMENTUM [which see].

Episcenium (Gr. ἐπισκήνιον). In ancient Architecture, the upper order of the scene in a theatre.

Episcopacy (Gr. ἐπίσκοπος, *an overseer*). The government of a church by three distinct orders of ministers—bishops, priests, and deacons. The nature of the argument upon which this constitution is defended will be clearly seen in a quotation from Bishop Short's *History of the English Church*. Speaking of the points at issue between the Presbyterians and the Church party in the reign of Elizabeth, he asks, 'Were there three distinct orders in the primitive church? and if so, was the right and office of ordaining peculiar to the highest of these?' He then proceeds to argue thus: 'In the apostolical history, as contained in the New Testament, these questions are not clearly answered, and there is much indistinctness about the names of *bishop* and *priest* or *elder*; but if we suppose, by way of hypothesis, that there were bishops, priests, and deacons, we shall find no statements which cannot be easily reconciled with the supposition. As we proceed with ecclesiastical history, those same traces become more decisive, till we find that at an early period the questions are both answered in the affirmative; and we infer, therefore, that unless it can be shown that a change in this particular took place, we may presume that the same ecclesiastical constitution existed from the time of the apostles. A Presbyterian might argue that in the apostolical history of the New Testament there is nothing which militates against the hypothesis of the two orders only, at least nothing which proves the point; that St. James might have been the chief elder, the moderator of the church of Jerusalem; that Titus and Timothy might have held no higher office than that of dean in a cathedral church, or archdeacon in a diocese; and that as the presbytery had the power of ordaining, they, as its superintendents, were directed by St. Paul to set all things in order. But then this hypothesis does not account for the introduction of episcopacy, without even a hint from the historians that any alteration in the church government was effected. When to this it is added, that there never existed a church without episcopacy till the Reformation, the proof seems as strong as moral proof can be that it is most probable that episcopacy is derived from the times of the apostles.' He adds in a note: 'The argument concerning the name of bishop is frequently mistaken. There is no doubt that ἐπίσκοπος is equivalent to πρεσβύτερος in the New Testament; but then the terms used in the New Testament for *bishop* are ἀπόστολος or ἄγγελος. The concession, therefore, of the use of the name ἐπίσκοπος proves nothing. The Presbyterian is forced to say, that the order equivalent to that of the apostles does not now exist in the church, and to explain ἄγγελος by *the chief pastor of the church*. So that the argument from the names is rather in favour of episcopacy.' It will be observed that this defence mainly relies upon the argument from antiquity and immemorial

usage; and this is the authority to which the Episcopalian always pays the highest regard when the Scriptures do not appear to be decisive. But the Presbyterians and Independents very generally take a different ground, and argue in the words of Dr. Maclaine, the translator of Mosheim—'that Christ, by leaving this matter undetermined, has of consequence left Christian societies a discretionary power of modelling the government of the church in such a manner as the circumstantial reasons of times, places, &c. may require; and therefore the wisest government of the church is the best and the most divine; and every Christian society has a right to make laws for itself, provided that these laws are consistent with charity and peace, and with the fundamental doctrines and principles of Christianity.'

Episcopalia or **Onera Episcopalia** (Lat.). In Ecclesiastical History, synodals or other customary payments from the clergy to their bishop or diocesan, which were formerly collected by the rural deans, and by them transmitted to the bishop. (*Mon. Ang.* iii. 61.)

Episode (Gr. ἐπεισόδιον). This word in its original sense denotes those parts of a classical drama which are between the entrances, εἴσοδοι, of the chorus; and thence, by analogy, has the signification which has adhered to the derivative word in modern use—an incidental narrative or digression in a poem, more or less connected with the main plot, but not essential to its developement.

Epispastic (Gr. ἐπισπαστικός, *attracting*). A term applied to substances which raise a blister upon the skin.

Episperm (Gr. ἐπί, and σπέρμα, *a seed*). In Botany, the testa or integuments of a seed.

Epistates (Gr. *a president*). The title of the presidents of the two great councils of the Athenians, viz. the Ecclesia and the senate of the Five Hundred. They were elected from the proedri of the ecclesia and senate, and their office lasted for one day, during which they kept the public records and seal.

Epistaxis (Gr. *a dripping*). Bleeding at the nose. In young persons, and where it is produced by accidental causes, this is of no consequence; unless, indeed, it should be very profuse, and then the topical application of cold and of styptics, especially a strong solution of alum, or a plug of lint properly introduced, will check it; but when it occurs frequently in advanced life, and is independent of nasal disease, it is apt to indicate fulness of the vessels of the head. It is a dangerous omen in disorders of great debility, and more especially in putrid fever.

Epistle (Gr. ἐπιστολή). In Ecclesiastical language, this word denotes those addresses by apostolical writers to their Christian brethren which are contained in the canon of Scripture; a few others, either spurious or of high antiquity, although not comprised in the canon, are also so denominated. The Epistles of St. Paul, and others in the New Testament, are not arranged according to their date, but, in all probability, according to the views which those who arranged the canon entertained of the relative importance either of the writings themselves, or of the parties to whom they are addressed. Thus the Epistles of St. Paul to the different churches, and the Catholic Epistles of St. John (i. e. addressed to the universal church), are ranked before their Epistles to individual Christians. An exception to this rule is found in the Epistle to the Hebrews, which is placed last among those commonly ascribed to St. Paul, and seems to have been admitted into the canon at a later period. The practice of reading a portion of an Epistle in the service of the church is extremely ancient, and is noticed by Justin in his *First Apology*.

Epistylium (Gr. ἐπιστύλιον). In Architecture, the same as Architrave [which see].

Epitaph (Gr. ἐπιτάφιος, sc. λόγος, from τάφος, *a tomb*). Literally, an inscription on a tomb. Among the Greeks this honour was paid only to the tombs of heroes, as in the case of Leonidas and his gallant comrades. (Her. vii. 228.) The Romans were the first to deviate from this course. Every Roman family who consecrated a tomb to their relations had the privilege of inscribing an epitaph thereon: and as their tombs were usually situated on the highway, the attention of passers-by was sought to be arrested by the words 'sta viator,' the formula with which their epitaphs were prefaced.

At what period sepulchral inscriptions came into use in England, has not been precisely ascertained; though there can be little doubt that this practice was introduced by the Romans at the period of their invasion of Britain. During the first twelve centuries of the Christian era, the monumental inscriptions of this country were all written in Latin. About the thirteenth century, the French language was adopted, and continued to be used for this purpose till the middle of the fourteenth century; at which time monumental inscriptions in the vernacular tongue became common, though the clergy and learned of that time, as might have been expected, still preferred the Latin, as their more familiar idiom. The modern English, French, and German epitaphs, of which several collections have been made, exhibit every variety of style and sentiment.

Epithalamium (Gr. ἐπιθαλάμιον). A nuptial song, sung by a chorus of boys and girls when the bride and bridegroom entered the bridal chamber, and again on the first morning after the marriage. The most perfect examples of this species left to us are by Theocritus and Catullus.

Epithelium (Gr. ἐπί, *upon*; θηλή, *a teat*). In Anatomy, a thin and delicate kind of cuticle, like that which covers the nipple. The term is now confined to the innermost layer of the internal cavities and canals of the body, which is analogous to the cuticle of the outer surface. The epithelia of the mucous membranes consist of the secreting cells of those surfaces, and are either *tessellated*, *cylin-*

droid, or *ciliated*. The tesselated, or *pavement epithelium*, is composed of flat, roundish, or polygonal cells, arranged in one or more layers, and is spread over the mouth, pharynx, and œsophagus; it is the kind of epithelium which most nearly resembles the external cuticle. A tesselated epithelium also lines most of the serous and synovial membranes, the vascular system, and the secerning tubuli and ducts of many glands. The *cylindroid* epithelium is composed of close-set cells of a conical or cylindrical form, and extends from the cardiac end of the stomach along the intestinal tract to the anus, and lines the principal gland-ducts which open upon this surface. It lines the ureters and urinary bladder.

The cells of the ciliated epithelium support at their free extremities fine pliant hair-like appendages called *cilia* which are in constant and rapid vibration: this kind of epithelium lines the whole respiratory tract, the interior of the cerebral ventricles, the uterus and oviducts, and the Malpighian capsules of the kidneys of the Batrachia.

Epithet (Gr. ἐπίθετον, *something imposed upon another*). In Rhetoric and Composition, a term employed in an adjective sense to express an attribute or quality of another substantive term.

Epitome (Gr. ἐπιτομή, *a cutting short*). In Literature, an abridgement: a work in which the contents of a former work are reduced within a smaller space by curtailment and condensation. In the later classical period, extending through the declining age of the Western Empire, the practice of epitomising the writings of older writers, especially in history, became very prevalent; and while some regard the works of Justin, Eutropius, and similar writers as having preserved to us much historical knowledge which would otherwise have been lost, others have maintained that these laborious compilers have done great mischief to literature, inasmuch as the voluminous works which they abridged were superseded by their more popular and cheaper compendia, in an illiterate age, and have from that cause for the most part perished. [ABRIDGEMENT.]

Epitrochoid (Gr. ἐπί; τροχός, *a wheel*; and εἶδος, *form*). The curve traced by a point in the plane of a circle which rolls on the convex side of a fixed circle. The curve thus generated belongs to the family of roulettes, and becomes an epicycloid when the generating point is in the circumference of the rolling circle. When the two circles are equal, the epitrochoid becomes similar to the pedal of the fixed circle with respect to a certain fixed point in its plane. [ROULETTE.] But the pedal being always the inverse of the reciprocal of the primitive curve [PEDAL], the epitrochoid in this case must be the inverse of a conic with respect to one of its foci, which latter is a curve of the fourth order, belonging to the family of Cartesian ovals, and known as the *limaçon*. [LIMAÇON.] Epitrochoids are in general transcendental curves; it is only when the circumferences of the fixed and rolling circles are commensurable that the epitrochoid returns into itself and becomes an algebraical curve.

Epizoans, Epizoa (Gr. ἐπί, *upon*, and ζῶον, *animal*). The name of a class of parasitic animals, which chiefly infest fishes, and of which the Linnæan genus *Lernæa* is the type.

Epizootic Diseases (Gr. ἐπί, *upon*, and ζῶον). When diseases prevail among inferior animals, they are said to be *epizootic*, corresponding to *epidemics* among men.

Epoch (Gr. ἐποχή, from ἐπέχω, *I stop*). In Astronomy, one of the elements of a planet's orbit.

EPOCH. In Chronology, a fixed point of time from which dates are numbered, or at which a new computation begins. [ÆRA.]

Epode (Gr. ἐπῳδός, *something added to the* ᾠδή, *or ode*). In the strophic choruses of the Grecian drama, the last portion following the strophe and antistrophe is so called. The name of *Epodes*, applied to a book of Horace's poems, merely signifies supplementary odes.

Epopee. [EPIC.]

Epopt. The name, ἐπόπτης, was given to all who were initiated in the Eleusinian Mysteries. [MYSTERIES.]

Epotides (Gr. ἐπωτίδες, from οὖς, ὠτός, *an ear*). In ancient Naval Architecture, two thick blocks of wood, resembling ears, one on each side of the prow of a galley, for warding off the blows of the rostra of an enemy's vessel.

Éprouvette (Fr.). In Gunnery, a machine for proving the strength of gunpowder. After the powder has been incorporated, a small mortar is placed vertically, and projects upwards a shot attached to a rod, which having ascended to its extreme height is prevented from descending by a small pawl catching in a rack. The height to which the shot ascends determines the strength of the powder. After the manufacture is complete, a shot is projected from a mortar, and by its range gives the strength of the powder.

Epsom Salt. Sulphate of magnesia; formerly obtained by evaporating the water of certain springs at Epsom in Surrey. The greater part of the Epsom Salt of commerce is now manufactured from the Magnesian Limestone of Yorkshire, to which the term *Epsomite* has therefore been applied.

Epulis (Gr. ἐπουλίς, *a gumboil*, from οὖλα, *gums*). A small tubercle on the gums.

Epulones (Lat.). Priests, appointed first in 196 B.C. to attend to the epulum Jovis, or banquets of Jupiter and the other gods. They formed one of the four great religious corporations at Rome: the other three being the Augurs, Pontifices, and Quindecemviri.

Epulotic (Gr. ἐπί, and οὐλή, *a scar*). Applications which promote the skinning over of sores; hence the *epulotic ointments* of old pharmacy.

Equant (Lat. æquo, *I make equal*). In the Ptolemaic Astronomy, this term denotes a circle which was conceived to be described in the

plane of the deferent or eccentric, for regulating and adjusting certain motions of the planets, and reducing them to easier calculation.

Equation (Lat. æquatio, *a making equal*). In Mathematics, the name given to the symbolical expression of the equality of two quantities or functions. The equation is said to be an *identical* one when it is satisfied for all possible numerical values of the symbols it contains; the functions equated are then equivalent forms of the same function. In other cases the equation may sometimes be satisfied or rendered identical by giving to one of the symbols x which it contains a particular value. Such a value is called a *root* of the equation, and being usually the object of investigation x is termed the *unknown quantity*. An equation is termed a *numerical* one when, besides the unknown quantity, it contains numerical symbols only; if besides these it contains literal representatives a, b, &c. of known but unstated numbers, the equation is termed a *literal* one. The solution of a literal equation consists of the expression of its root x in terms of the remaining letters. This *general solution* is not always possible in a finite form; on the other hand, the solution of a numerical equation to any required degree of accuracy, can usually be accomplished by certain *methods of approximation*. One of these methods, Newton's, on account of its general applicability, may be here mentioned. If a be an approximate root of the equation $f(x)=0$, a form to which every equation can obviously be reduced, then a still more approximate root will, in general, be $a-\dfrac{f(a)}{f'(a)}$, where $f'(a)$ is the first *derived function* of $f(a)$.

An equation is said to be *algebraic* when the operations to which the unknown quantity x is subjected do not transcend the ordinary algebraical operations of addition, subtraction, multiplication, division, involution, and evolution; in other cases the equation is termed *transcendent*, and receives the distinctive names of *exponential*, *logarithmic*, *trigonometrical*, &c., according to the nature of the functions of x which it involves. An algebraic equation is further said to be rational and integral when, in it, the unknown quantity neither appears in the denominator of a fraction nor under any radical sign. It is evident that every algebraic equation can be rendered rational and integral by means of appropriate transformations.

Equation of Differences. An expressed relation between an independent variable x, a dependent variable u_x, and the successive differences Δu_x, $\Delta^2 u_x$ &c. of the latter. These differences are, of course, expressible also by the successive values u_x, u_{x+1}, u_{x+2}, &c. . .
Thus

$$\Delta u_x + 2\dot{u}_x + x + 1 = 0$$

and

$$u_{x+1} + u_x + x + 1 = 0$$

are equivalent forms of an equation of differences. [Differences, Calculus of.] Equations of differences are classified according to their order and degree in precisely the same manner as differential equations, and there are many points of resemblance in the methods by means of which both are solved.

An *equation of partial differences* involves in general two or more independent variables x, y . . , an unknown dependent variable $u_{x,y}$, and one or more of the partial differences or partial successive values of the latter. Thus

$$\Delta_x \Delta_y u_{x,y} + \Delta_x u_{x,y} - u_{x,y} = 0,$$
$$D_x D_y u_{x,y} - D_y u_{x,y} - u_{x,y} = 0,$$
$$u_{x+1,\,y+1} - u_{x,\,y+1} - u_{x,y} = 0$$

are equivalent forms of an equation of partial differences of the second order.

The best systematic English treatises on the solution of equations of differences have been already cited. [Differences, Calculus of.]

Equations of mixed differences are characterised by the simultaneous presence of differences and differentials. Although noticed in De Morgan's *Differential and Integral Calculus*, in Boole's *Finite Differences*, and in several other works, these equations have been but little investigated.

Equation of Squared Differences. In Algebra, the equation whose roots are the squares of the differences of the roots of a given equation. If the latter is of the n^{th} degree, the degree of the former will be $\dfrac{n(n-1)}{2}$, for there are so many combinations of n roots of the form $(a_1-a_2)^2$, $(a_1-a_3)^2$ &c. The coefficients of the equation of squared differences can of course be calculated as soon as the sums of the several powers of its roots are known. [Symmetric Functions.] The latter, however, are obviously expressible by means of symmetrical functions of the roots of the original equation, in fact by the sums of the powers of its roots, and hence in terms of the known cofficients of this equation. Calling S_r and s_r, respectively, the sums of the r^{th} powers of the roots of the original equation, and of the equation of squared differences, it is found that

$$s_2 = n\,S_{2r} - 2r\,S_1 S_{2r-1} + \frac{2r(2r-1)}{1\,.\,2} S_2 S_{2r-2}$$
$$\ldots + (-1)^r \frac{2r(2r-1)\ \ldots\ (r+1)}{2\underline{r}} S_r S_r\,.$$

The equation of squared differences may be used in separating the real roots of the original [Waring's Method]; it furnishes information, too, with respect to the number of *imaginary* roots of the latter, for it is manifest that the negative as well as the imaginary roots of the equation of squared differences must proceed from imaginary roots of the original, and that the absence of negative roots in the former will necessarily imply the reality of all the roots of the latter.

Equation, Functional. [Function.]

Equation, Personal. The term *personal equation* has of late been introduced into Astronomy to denote the interval of time by which

an observer, on the average of a number of observations, notes a phenomenon before or after the instant assumed to be that of its actual occurrence. If it were possible to determine the true instant of the occurrence of any phenomenon with absolute certainty, the personal equation of an observer would be the amount of error he is in the habit of making, or the probable error of a single observation made by him; but as the true instant of the occurrence can only be assumed by taking the mean of a number of observations, the term has only a relative signification. For instance, if, on comparing a number of observations of the same phenomenon by A and B, it be found that A notes the phenomenon, on the average, half a second sooner than B, then half a second is the *difference* of their personal equations; but this does not enable us to form any judgment with respect to the amount of error due to either, and it is only by a further comparison of observations made by A and B with those of other observers, that we are enabled to assume that the true instant at which the event occurred lies between the times noted by them respectively, or before or after both. If, however, it be assumed that either A or B observes correctly, then the personal equation of the other is half a second.

Generally speaking, the personal equation of an observer is a minute quantity, seldom exceeding a few tenths of a second, but it is sometimes found even in the case of experienced observers to amount to, or even exceed, a whole second. It is found to vary with the age of the observer, and may possibly at all times depend in some measure on the state of his health. See Introductions to the volumes of the *Greenwich Observations*.

Equation of the Centre. The quantity by which the true longitude of the earth differs from the mean longitude.

Equation of Time. In Astronomy, the difference, expressed in mean solar time, between the true or apparent right ascension of the sun and its mean right ascension. It may be somewhat popularly defined as the difference between the times indicated by an accurately constructed sun-dial and a well-regulated clock.

The equation of time arises from the combined operation of all the causes which tend to produce inequalities of the sun's motion in right ascension. The first of these is the eccentricity of the earth's orbit, in consequence of which the sun's motion in longitude is unequal. The second is the obliquity of the ecliptic, in consequence of which the arcs of the ecliptic and equator, counting from the intersection of these circles to the meridian, are in general unequal. A third, but comparatively unimportant, cause arises from the perturbations of the moon and planets.

The equation of time is at its maximum about the beginning of November, when it amounts to about 16 min. 16 sec.; and is subtractive, that is to say, the clock is faster than the dial by that quantity. At four times in the year the equation vanishes, or the clock time and dial time agree. This happens about the 25th of December, the 16th of April, the 16th of June, and the 1st of September. But these epochs, depending on the longitude of the sun's perigee, are subject to some variation. The equation is given in the *Nautical Almanac* for every day of each year.

Equations, Binomial. [BINOMIAL EQUATIONS.]

Equations, Reciprocal. [RECIPROCAL EQUATIONS.]

Equations, Theory of. Under this name it is customary to include that branch of Algebra in which are investigated the properties of algebraic equations, reduced to the rational and integral form,

$$F(x) = A_0 x^n + A_1 x^{n-1} \ldots + A_{n-1} x + A_n = 0,$$

where the coefficients A_0, A_1, &c., denote real quantities. The great problem with the earlier algebraists was the *solution* of such equations, that is to say the discovery of those functions of the coefficients (*roots*) which, when substituted for x, have the property of satisfying the equation by rendering it an identical one. [EQUATION.] In 1826, however, the Norwegian mathematician Abel (*Œuvres Complètes*) proved that the problem was an impossible one, in finite form, when the degree n of the equation exceeded four. The problem had already been virtually solved for equations of the second, third, and fourth degrees, respectively, by the Hindu algebraists, by the Italian Cardan, and by his pupil Ferrari. [QUADRIC; CUBIC; BIQUADRATIC; and QUARTIC.] Although our powers are thus limited, however, with respect to the *general* solution of equations, we are not only in possession of methods by which the roots of *numerical* equations can be determined to any required degree of accuracy [HORNER'S METHOD], but by the *theory of equations* we can discover numerous properties of these roots. The more important of these properties we propose merely to enunciate.

1. If a be a root of the equation $F(x) = 0$, then the function $F(x)$ is exactly divisible by the binomial $x - a$; and conversely if $x - a$ is a divisor of $F(x)$, a is a root of the equation. When $F(x)$ is divisible by $(x-a)^m$, the equation is said to have m *equal roots*, a being their common value.

2. Every equation of the n^{th} degree has n real or imaginary roots, and may therefore be written in the form—

$$F(x) = A_0 (x - a_1)(x - a_2) \ldots (x - a_n) = 0.$$

If, of the roots a_1, a_2 &c., one should be imaginary or of the form $a + b\sqrt{-1}$, it will necessarily be accompanied by its *conjugate* $a + b\sqrt{-1}$, and the two will give rise to the *real* quadratic factor $(x-a)^2 + b^2$.

3. The sum of all the roots of the equation $F(x) = 0$ is equal to $-\frac{A_1}{A_0}$, that of the products

of every two roots to $\frac{A_2}{A_0}$, &c., generally the sum of the products of every m of the roots is equal to $(-1)^m \frac{A_m}{A_0}$. As a particular case it follows that the product of all the roots must be equal to $(-1)^n \frac{A_n}{A_0}$.

4. Every rational and symmetrical function of the roots of an equation can be expressed in terms of its coefficients. [SYMMETRICAL FUNCTIONS.] In obtaining such expressions, the following easily demonstrated theorem is of great service:

5. If $f(x)$ be any rational and integral function of x, and $F'(x)$ the derived function of $F(x)$, then the coefficient of the highest power of x in the remainder, obtained by dividing $F'(x) f(x)$ by $F(x)$, is $f(a_1)+f(a_2)+\ldots f(a_n)$.

6. There will necessarily be an odd number of real roots between a and β if $F(a)$ and $F(\beta)$ have opposite signs, and an even number (or none) if these functions have the same sign.

7. Between every pair of adjacent real roots of $F(x)=0$ lies a real root of the derived equation $F'(x)=0$.

8. If $F(x)=0$ have m roots (real or imaginary) each equal to a, $m-1$ of them will also be roots of $F'(x)=0$. The equal roots of an equation, therefore, may always be detected and removed. For the latter purpose it is merely necessary to divide $F(x)$ by the greatest common measure of $F(x)$ and $F'(x)$.

9. If f denote the numerical value of the first coefficient in an equation, and g that of the numerically greatest coefficient which has a sign opposite to that of the first, then no positive root can be so great as $1+\frac{g}{f}$. This theorem suffices at once for the discovery of inferior as well as of superior limits to both positive and negative roots.

With reference to the methods of ascertaining the number of real and imaginary roots between given limits, see STURM'S THEOREM and FOURIER'S THEOREM, of which latter Descartes' useful *rule of signs* is but a particular case. On the theory of equations we have, in English, treatises by Murphy, Young, Hymers, Todhunter and others, and, in French, an excellent work by Serret, *Algèbre Supérieure* (Paris 1849), as well as less recent, but valuable ones by Budan, Lagrange, Fourier and others.

Equator. In Astronomy, the great circle of the celestial sphere, of which the plane is perpendicular to the axis of the earth's diurnal motion. It is called the equator, because when the sun is in its plane the days and nights are exactly equal all over the world. The equator divides the sphere into the northern and southern hemispheres, and the apparent diurnal motions of all the celestial bodies are performed in circles which are parallel to it. The right ascensions are measured on the equator; and the declinations on circles which intersect it at right angles. The equator, in the heavens, is often styled the *equinoctial*.

In Geography, the equator is the great circle of the terrestrial sphere which is everywhere equally distant from the two poles, and divides the earth into the northern and southern hemispheres. Terrestrial *longitudes* are measured on the equator, or some one of its parallel circles; commencing from some arbitrary point, which different nations assume variously, most of them adopting the meridian which passes through their capital city or principal observatory. *Latitudes* are counted from the equator along the meridian.

Equatorial. An astronomical telescope, mounted for the purpose of continuously observing and noting the right ascension and declination of a celestial body situated in any part of the visible heavens, as opposed to the *transit-instrument*, which is used only in the meridian of the place, and to the *altitude* and *azimuth* instrument, which measures those coordinates from which its name is derived. The principal axis of the equatorial mounting is parallel to the earth's axis, and by means of this construction it is possible to follow a star from rising and setting by driving the telescope, either by hand or machinery, westward, at the same rate at which the earth's motion carries it eastward. On the polar axis there is fixed a graduated circle, the plane of which is perpendicular to the polar axis, and therefore parallel to the earth's equator. This is called the *hour* circle, and is furnished with two indices. If one be set to sidereal time at the place of observation, which of course represents the right ascension of the part of the heavens then crossing the meridian, the other index will show the right ascension of the part of the heavens to which the telescope points. In this manner the right ascension of a comet, for instance, may be at once found or the telescope may be pointed to any given right ascension. But the telescope itself is attached to another axis, called the *declination axis*, at right angles to the former one; and to this axis is also attached at right angles another circle, the *declination circle*. The plane of the second circle and of the telescope's motion in declination is thus in all positions at right angles to the plane of the first or equatorial circle. Now it is easy to conceive, from this general description, that when the telescope is pointed to a star, the angle between the direction of the telescope and the polar axis is equal to the polar distance of the star; and by setting the index of the declination circle to zero when the telescope is at right angles to the polar axis, the declination of a star is registered in all positions of the instrument; consequently, when a motion is given to the polar axis without altering the position of the telescope on the declination circle, the point to which the telescope is directed will always lie in the small circle of the heavens coincident with a star's diurnal path; and hence, if the motion communicated to the polar axis be equal to the earth's diurnal rotation, a star will remain constantly in the field. The best equatorials are now furnished with *driving clocks*. Besides relieving the observer from the fatigue of turning

the instrument, the motion thus given is perfectly equable, and all those jerks are avoided which, when the instrument is turned by the hand, often prove fatal to an observation. [TELESCOPE.]

Equatorial Current. An important part of the stream currents of the Atlantic, first distinctly traceable off the coast of Africa, a little south of the equator, whence it continues to run, nearly on the line, for a distance of 1,000 miles as far as 22° west longitude. It then sends off a branch to the north-west, and declining southwards runs for some distance parallel to the coast of South America until it is lost sight of near the mouth of the Amazons. Including both branches, it has a course of about 4,000 miles. Its breadth, at first only 150 miles, becomes three times as great where it branches near the South American coast. It has a mean velocity of 36 miles per day, but at certain seasons and in some part of its course it has been recorded as reaching more than three and a half miles an hour. It is generally throughout its course a cold current, but the difference is not more than four or five degrees when compared with the mean temperature of the ocean in any given latitude.

The northern portion of this great current passes along the coast of Guiana and enters the Caribbean Sea, where it is ultimately lost, or perhaps is converted into warm water, and then is passed out through the gulf of Mexico into the Atlantic to assist in forming the GULF STREAM [which see].

Equerry (Fr. écuyer). In the British court, a subordinate officer under the master of the horse. The chief equerry is also styled *clerk marshal*, with a salary of 500*l*. per annum. There are also four equerries in ordinary, whose salary is 300*l*. a year, and an equerry of the crown stable. A queen consort has three equerries.

Equiangular. In Geometry, two or more figures of the same kind (usually rectilinear) are said to be equiangular when the angles of the one, taken consecutively, are respectively equal to the angles of the other. A single figure is also said to be equiangular when all its angles have the same magnitude.

Equiangular Spiral. A name sometimes given to the logarithmic spiral in consequence of its having the property of cutting, at the same angle, all its polar radii vectores. [LOGARITHMIC SPIRAL.]

Equilateral (Lat. æquilateralis, from latus, *a side*). In Geometry, a rectilineal figure is said to be equilateral when all its sides are equal. If, moreover, its angles are all equal, it is called *regular*. Every equilateral figure inscribed in a circle is necessarily equiangular, and therefore regular. The converse theorem, however, is only true for polygons with an odd number of sides. Equiangular inscribed polygons with an even number of sides, if not equilateral, will at least have every alternate side equal.

Equilateral Bivalve. A shell is so called when a transverse line drawn through the apex of the umbo bisects the valve into two equal and symmetrical parts.

Equilateral Hyperbola (Gr. ὑπερβολή). An hyperbola whose axes are equal. Its asymptotes being perpendicular to each other, it is sometimes called also a *rectangular hyperbola*. Every equilateral hyperbola cuts the line at infinity in two points which are harmonic conjugates with respect to the imaginary circular points in that line, and conversely every conic which so cuts the line at infinity is necessarily a rectangular hyperbola. From this may be deduced the interesting property that every conic which passes through the intersection points of two equilateral hyperbolas is itself an equilateral hyperbola.

Equilateral Hyperbolic Paraboloid. A quadric conoidal surface generated by a right line which, during its motion, rests upon two other right lines or *directrices*, to one of which it always remains perpendicular. [QUADRIC.]

Equilibrium (Lat. æquilibrium, from libra, *balance*). The state of rest produced by two or more mutually counteracting forces. [COMPOSITION AND RESOLUTION OF FORCES.]

EQUILIBRIUM. In the Fine Arts, the just place or balance of a figure, or other object, so that it may appear to stand firmly. Also the due equipoise of objects, lights, shadows, &c., against each other by some striking features. This quality is obvious in the works of nature, as well in the human form as in landscape. In the latter, for instance, the sun is generally the medium of producing it by strong contrasts of light and shadow. In Architecture, the same means are employed to produce the most striking effects.

EQUILIBRIUM. In Politics. [BALANCE OF POWER.]

Equilibrium Surface. In the theory of attraction, one which is everywhere normal to the resultant of attraction upon any material particle placed thereon. Its equation is obtained by putting the potential equal to a constant. The equilibrium surface is the orthogonal trajectory of the *lines of force*. [POTENTIAL.]

Equimomental Cone and Surface. [INERTIA, MOMENT OF.]

Equimultiples. Two or more magnitudes, alike or unlike in kind, are said to be equimultiples of as many other like magnitudes, when each magnitude of the first set contains the corresponding magnitude of the second set the same number of times. Thus mA and mB are equimultiples of A and B, whatever magnitudes the latter may represent.

Equinoctial. [EQUATOR; EQUINOX.]

Equinoctial Time. Astronomers sometimes give the date of an occurrence in equinoctial time to get rid of local differences. This is reckoned from the moment when the point of Aries passes the vernal equinox.

Equinoctial Points. The two opposite points of the celestial sphere, in which the ecliptic and equator intersect each other; the one being the first point of Aries, and the other

the first point of Libra. The equinoctial points do not retain a fixed position relatively to the stars, but retrograde or move backwards from east to west with a slow motion, equal to about 50 seconds yearly, requiring 25,000 years to accomplish a complete revolution. This motion is called the PRECESSION OF THE EQUINOXES [which see].

Equinox (Lat. æquus, *equal*, and nox, *night*). In Astronomy, the time at which the sun passes through the equator in one of the equinoctial points. When the sun is in the equator, the days and nights are of equal length all over the world, whence the derivation of the term. This happens twice every year; namely, about the 21st of March and the 22nd of September: the former is called the *vernal* and the latter the *autumnal* equinox. The equinoxes do not divide the year into portions of equal length; for in consequence of the earth being at its greatest distance from the sun during the summer months, and its angular motion in its orbit being consequently slower, the interval from the vernal to the autumnal equinox is greater than that from the autumnal to the vernal. In other words, the sun continues longer on the northern than on the southern side of the equator. At the beginning of the present century, the difference amounted to 7 days 16 hours and 51 minutes. The summer in the northern hemisphere is consequently longer than in the southern by this quantity; and to this circumstance some meteorologists ascribe, in part at least, the higher temperature that is found to prevail in the northern hemisphere under the same parallel. [PRECESSION.]

Equipage (Fr.). In ordinary language, signifies the carriage, horses, and liveries which indicate the fortune or rank of any gentleman when he appears abroad.—*Equipage*, in marine affairs, signifies the crew of a ship, together with all a ship's furniture, masts, sails, ammunition, &c.—In military language, *Camp equipage* means the tents and appliances necessary for encampment.

Equipollence (Lat. æquipolleo). In Logic, when two or more propositions signify one and the same thing, though they express it differently.

Equipollence, Calculus of. In Mathematics, a symbolical calculus, invented by Professor Bellavitis of Padua. In many respects it is analogous to the barycentric calculus of Möbius, the double algebra of De Morgan, and the calculus of quaternions of Sir W. R. Hamilton. (*Memorie dell' Istituto beneto di Scienze*, vol. viii. 1860.)

Equipotential Surface. [POTENTIAL.]

Equiria (Lat. from equus). Roman horse-racing games, said to have been instituted by Romulus in honour of Mars; they were celebrated twice every year in the Campus Martius.

Equisetaceæ (Equisetum, one of the genera). In Botany, a natural order of Cryptogams, inhabiting the ditches and rivers of most parts of the world. They have no decided affinity with any known order, but bear an external resemblance to such Gymnosperms as *Ephedra*, and in their fructification to the order of Cycads. They have no medicinal qualities; but for economical purposes are useful for polishing furniture, owing to the quantity of silex contained in their epidermis. For this latter purpose, large quantities of *Equisetum hyemale* are imported under the name of Dutch Rushes. They are considered by the farmer, who calls them Horse-tails, as a sign of heavy, bad, wet land.

Equisetic Acid. A peculiar acid, discovered by Braconnot, existing, combined with magnesia, in the *Equisetum fluviatile*.

Equitangential Curve. One whose tangents are all intersected by a given line at the same distance from the respective points at contact. [TRACTRIX.]

Equitant (Lat. equitare, *to ride*). In Botany, a term used in describing the venation of leaves, to denote that they overlap each other entirely and without any involution, as the leaves of the iris.

Equites (Lat. *horsemen*). In Ancient History, a class of Roman citizens, commonly represented by the English word *knights*, but not answering in all respects to its meaning. According to the account of Livy (i. 13), Romulus constituted three centuries of equites, to whom he gave severally the names Ramnenses, Titienses, and Luceres. Livy, however, elsewhere speaks of these three centuries (who were collectively called Celeres) as the three ancient *tribes*. (Sir G. C. Lewis, *Credibility of Early Roman History*, i. 438 &c.) Down to the time of Gracchus, the equites formed simply a division of the army, and their centuries were composed of patricians and plebeians; but by the Lex Sempronia, B.C. 123, a new class called the Ordo Equestris was instituted, and all the judices, who assisted the prætor in trials, were to be citizens of equestrian fortune. The reform of Sulla deprived the equites of the sole right of being chosen as judices, and the latter were now to be chosen from the senators, equites, and tribuni ærarii. The badges of the equites were a golden ring and a robe with a narrow purple border; and to them were appropriated the fourteen rows of seats in the theatres next the orchestra. The equites furnished the farmers of the public revenue, or publicani; but though they had enjoyed this privilege under the republic, it was only during the empire that they looked to such offices as their birthright. Cicero affirms that the flower of the Roman chivalry, the ornament of Rome, the strength of the empire, lay in these farmers of the public revenue: 'Florem equitum Romanorum, ornamentum civitatis, firmamentum reipublicæ, publicanorum ordine contineri.'

Equity (Lat. æquitas). In Jurisprudence. In the words of Blackstone (*Commentary* i. 61), 'Since in laws all cases cannot be foreseen or expressed, it is necessary that when the general decrees of the law come to be applied to particular cases, there should be somewhere a power vested of defining those circumstances which (had they been foreseen) the legislator himself would have expressed.' In the same

view, Grotius defines equity as 'Correctrix ejus in quo lex propter universalitatem deficit' (*De Æquitat.* i. s. 12); and distinguishes it from the dispensing power, which does not mitigate law, but dispenses certain persons from the obligation of it. Puffendorf considers it under two heads—as declaring a case to be excepted out of the general provisions of a law; and as deciding omitted cases on which the law does not pronounce at all. (*Elements*, i. 22, 23.) The necessity of some power to modify and apply, with allowances for particular cases, the strict rules of law, is necessarily felt in every jurisprudence, and provided for in different ways. Thus in ancient Rome the prætor, 'juvare, supplere, interpretari, mitigare, jus civile potuit; mutare vel tollere non potuit.' (*Digest*, l. i. t. l. 7.) So, in English law, the judges have constantly assumed the authority to pronounce cases to be within the *equity*, as it is termed, of statutes or rules, when they are not within its words; as, for example, action of waste given by the Statute of Gloucester against tenant for life 'or years' is extended by equitable construction against tenants who hold for a year or half a year only. But the word *equity*, in English jurisprudence, is now more properly applied to a separate body of law, created and sustained on the strength of precedents, and administered by tribunals distinct from the common law courts of the country. The separation of equity from law originated in the necessity which has already been spoken of; but from the circumstance of the former being administered by a different class of functionaries, it has by degrees assumed this distinct shape and substance. By seeking relief in equity is now meant, not so much applying for a mitigation of the strict rules of law, as seeking a remedy before a tribunal having a jurisdiction either concurrent with the courts of law or (in some cases) exclusive, but exercising it according to a different process and on different principles. The origin of this peculiar system is to be traced, in part, to the system of uses [Use; Trust]; in part to the obvious advantages resulting from the examination of the parties, and compelling discovery on oath in cases of fraud, account, &c.; and to the power, gradually acquired by equity judges, of compelling the specific performance of contracts where courts of law could only award damages for their breach; in part, also, to the peculiar functions imposed by statute and usage on the lord chancellor as guardian of infants, idiots, and lunatics, superintendent of charities, &c. The general view of the system of equitable jurisprudence as at present existing is given in the articles Chancery and Trust. (Blackstone's *Commentaries*, vol. iii.; Fonblanque *On Equity*; Story's *Equity Jurisprudence*; White and Tudor, *Leading Cases in Equity*.)

Equity of Redemption. In Law. [Mortgage.]

Equivalents, Chemical. A term introduced into Chemistry by Dr. Wollaston to express the system of definite ratios in which substances reciprocally combine, referred to a common standard of unity. If we assume hydrogen as unity, it being the substance which combines with others in the smallest relative weight or proportion, then all other substances may be represented by certain multiples of that unit, expressed with sufficient precision for ordinary purposes by whole numbers. [Atomic Theory; Affinity.] Thus, upon this system the equivalent number of oxygen will be 8, and that of water will be 9, for 8 oxygen + 1 hydrogen = 9 water; the equivalent of potassium will be 39 and of potassa or oxide of potassium 47, for 39 potassium + 8 oxygen = 47 potassa. Upon the same principle the equivalent of hydrochloric acid, which is a compound of chlorine and hydrogen, is 37, for it consists of 1 part by weight of hydrogen and 36 of chlorine; or, in other words, of an atom of hydrogen = 1 + an atom of chlorine = 36. The equivalent of sulphur is 16: to form sulphuric acid one atom of sulphur = 16 combines with 3 atoms of oxygen $(8 \times 3) = 24$; hence the equivalent of an atom of sulphuric acid is $16 + 24 = 40$. These equivalents are often expressed by certain abbreviations, termed *chemical symbols*, which, as far as single equivalents of the simple substances are concerned, are represented, together with their equivalent numbers, in a table in the article Chemistry.

Equivalve. A bivalve is so called when its two valves are of similar size and form.

Equivocal Term (Lat. æquivocus, *ambiguous*). In Logic, a term which has several significations, applying respectively and equally to several objects. A word is generally said to be employed equivocally where the middle term is used in different senses in the two premisses [Syllogism]; or where a proposition is liable to be understood in various senses, according to the various meanings of one of its terms.

Equuleus (Lat.). Called also *Equiculus* and *Equus Minor*. The *Little Horse*; one of Ptolemy's constellations in the northern hemisphere.

Equuleus. In Roman Antiquities, the name given to a species of rack used in extorting confessions.

Equus (Lat. *a horse*). The generic name of the quadrupeds with a single digit and hoof on each foot, as the *horse*, *ass*, and *zebra*. Of these species the horse is the largest, most docile, most valuable, and most widely distributed over the globe. Of the Mammalia which existed on the earth's surface during the tertiary periods of geology, the horse is one of the few which have been preserved to the present epoch; and in the American continent, where it once became extinct, along with the Mastodon and Megatherium, it now again ranges wild in vast troops, the descendants of the war-horse introduced by the European discoverers and conquerors of the so-called New World.

The wild horses which inhabit the steppes of Tartary are supposed to be, like those that traverse the pampas of South America, the descendants of certain individuals which have

escaped from the thraldom of man. The best of the wild Asiatic races are those which inhabit Tscherkessi Abassi, and the northern slopes of the Caucasian range. The principal varieties which Pallas indicates in the Asiatic horse are: the *mustachoed horse*, characterised by numerous strong bristles on the upper lip; the *woolly horse*, a Russian variety, covered with a crisp woolly hair, and common among the Baschkirs; a *hairless* or naked horse, not uncommon amongst the Krim Tartars, who keep it always clothed; and lastly, the variety delineated by Johnston, in which a woolly mane is continued from the neck along the middle of the back to the tail, and which Pallas saw among the Buracti.

The wild horses appear to be free from nearly all those diseases to which the domestic breed are prone. They are generally of a pale or greyish-brown colour, with brown mane and tail, a whitish muzzle, changing to black about the mouth. They are less than the domestic breed; with a larger head; longer legs; larger ears, with the apices sub-reflected; the forehead is more convex above the eyes; the hoofs are contracted and subcylindrical (*ungulæ contractæ, subcylindraceæ*); mane sub-erect, less lax than in the domestic horse; the coat, in winter, looser and subundulating along the back (*in dorso subundulatum*); the tail not very large. They recognise the presence of man at a great distance when he approaches them to windward, and fly from him with wonderful speed; they prefer sunny slopes, and avoid forests and steep places. They do not wander beyond the 50th degree of north latitude.

The first change which domestication works upon the form of the wild horse is to increase the bulk of his trunk as compared with his head and limbs. This change is beautifully exemplified in the Arabian, which we must regard as an early, if not first, remove from his wild neighbours of the more northern deserts, which the Bedouin still hunts for the sake of their flesh. The head is not only proportionally smaller, but is remarkable for the breadth and squareness of the forehead, the shortness and fineness of the muzzle, the prominence and brilliance of the eye, and the smallness of the ears. The body is still somewhat light, and narrow at the forepart; but the shoulder is superior in its formation to that in any other breed. The Arabian seldom stands more than fourteen hands two inches. The *Barb*, so called from its native country, Barbary, is somewhat smaller than its near ally the Arabian; it seldom exceeds fourteen hands and an inch; the shoulders are flat, the chest round, the legs rather long, and the head small and very beautiful. The Barb is remarkable for its fine and graceful action; but though it is superior to the Arabian in its general form, it has not its untiring spirit or its speed. Our most valuable English varieties of the horse date from the introduction of, and interbreeding with, the Barb and Arabian.

We have no means of ascertaining the nature or peculiarities of the horses which the ancient British charioteers managed with such dexterity in their destructive charges through the disciplined troops of Cæsar. They must have been subsequently modified by crossing with the Roman horses. King Athelstan received from Hugh Capet of France several German running horses; William the Conqueror and his followers introduced the Spanish horse, with the blood of the Barb. The first Arabian horse is recorded to have been introduced in the reign of Henry I.; and a greater admixture of Arabian blood was a natural consequence of the return of the Crusaders. King John devoted especial attention to the improvement of his stud; and he imported one hundred choice stallions of the Flanders kind. The size and strength required to carry the warrior clad in the heavy armour of those days led to the frequent introduction in subsequent reigns of the large and heavy war-horses of the Low Countries. Afterwards, when the nobles derived their amusements more from the sports of the turf and field, they were induced to cross their stately and heavy breed of war-horses with those of lighter structure and greater speed; the latest improvement seems to have been derived from a direct intermixture of the pure Arabian.

The principal varieties of breeds of English horses are: The hackney or road horse. 'He should be,' Mr. Youatt observes, 'a hunter in miniature; with these exceptions: His height should rarely exceed fifteen hands and an inch. He will be sufficiently strong and more pleasant for general work below that standard. He should be of a more compact form than the hunter, of more bulk according to his height. It is of essential consequence that the bones beneath the knee should be deep and flat, and the tendon not *tied in*. The pastern should be short, and less oblique or slanting than that of the hunter or racehorse. The foot should be of a size corresponding with the bulk of the animal, neither too hollow nor too flat, and open at the heels. The forelegs should be perfectly straight; for a horse with his knees bent will from a slight cause, and especially if over-weighted, come down. The back should be straight and short, yet sufficiently long to leave comfortable room for the saddle between the shoulders and the *back* without pressing on either. Some persons prefer a hollow-backed horse. It is generally an easy one to go. It will canter well with a lady; but it will not carry a heavy weight or stand much hard work. The road horse should be high in the forehead, round in the barrel, and deep in the chest.'

The origin of the better kind of *coach horse*, says Mr. Youatt, is the *Cleveland bay*, confined principally to Yorkshire and Durham, with Lincolnshire on one side and Northumberland on the other, but difficult to meet with pure in either county. The Cleveland mare is crossed by a three-fourth or thorough-bred horse of sufficient substance and height, and the produce is the coach horse most in repute, with his arched crest and high action.

There is, or rather was, a breed called, from its round punchy make, the *Suffolk punch.* 'It stood from fifteen to sixteen hands, of a sorrel colour; was large-headed, low-shouldered, and thick on the top; deep and round-chested; long-backed; high in the croup; large and strong in the quarters; full in the flanks; round in the legs, and short in the pasterns. It was the very horse to throw his whole weight into a collar, with sufficient activity to do it effectually, and hardihood to stand a long day's work.' This valuable breed is now nearly extinct: it is thought to have been produced from the Norman stallion and the Suffolk cart mare. Excellent carriage horses are obtained by crossing the Suffolk breed with a good hunter.

The best dray horses are produced from the Suffolk punch crossed with the Flanders.

The breed of English racers is traced authentically to an Arabian stallion introduced into this country by a Mr. Darley, and hence called the *Darley Arabian.* Anterior to this period the pedigree of a racer can rarely be carried back beyond some obscure reference to an Eastern horse. The Darley Arabian was the sire of Flying Childers, and the great-grandsire of Eclipse. Eclipse was remarkable for the very great size, obliquity, and lowness of his shoulders; the shortness of his forequarters; his ample and finely proportioned quarters, and the swelling muscles of his fore-arm and thigh. He was, moreover, what is termed a *thick-winded* horse, and puffed and roared so as to be heard at a considerable distance; yet he never had an opponent on the turf sufficiently fleet to put his full speed to the test. Eclipse died at the age of twenty-five years, having begot the extraordinary number of three hundred and thirty-four winners. Another stream of Eastern blood was introduced into the swelling veins of our thorough-bred horses by a beautiful Barb, called the *Godolphin Arabian.*

The hunter, a favourite English variety, includes as much of the blood and high breeding of the racer as is compatible with the power and endurance demanded by the chase. The author of the excellent work on the horse in the *Library of Useful Knowledge* thus describes the good points of a hunter: 'The first property of a good hunter is, that he should be light in hand. For this purpose his head must be small; his neck thin, especially beneath; his crest firm and arched; and his jaws wide. The head will then be well set on. It will form a pleasant angle with the neck, which gives a light and pleasant mouth.'

The more extreme varieties which we have in England are the ponies and Galloways: of these the Sheltie or Shetland pony is the most diminutive; it rarely exceeds nine hands high, and sometimes does not reach seven and a half. His strength is proportionally far greater than his size; he is perfectly docile, and will fatten on the hardest fare.

The dental character of the horse, and of the genus *Equus*, is thus expressed in zoology:—

incisors $\frac{6}{6}$, canines $\frac{1-1}{1-1}$, molares $\frac{6-6}{6-6}=40$;

i.e. it has six incisors or nippers in the front of both the upper and lower jaws, one tusk or canine, and six molars or grinders, on each side of both jaws. They appear in the following order. The two middle incisors and the two anterior grinders come into place at about a week after birth; the third grinder in the course of the first month; the two adjoining incisors before the end of the sixth week; the two outer incisors between the sixth and ninth month; making the six incisors above and below, and completing what is termed the *colt's mouth.* There are also two very small deciduous canines developed about the sixth month; the fourth grinder generally makes its appearance at the end of the first year, and thus the formula, incisors $\frac{6}{6}$, molares $\frac{4-4}{4-4}$, is characteristic of the yearling foal. A fifth grinder makes its appearance at the end of the second year; and now commences the displacement of the first set, and the protrusion of the second or permanent set of teeth. The deciduous teeth are lost in the order of their acquisition; the two middle incisors of both the upper and lower jaws are displaced *between the second and third years*; the first and second deciduous grinders are shed at two years and eight months. A *three-year old* colt has the permanent middle incisors above the gum, but not on a level with the adjoining deciduous incisors; they are also characterised by a large and deep groove containing a black substance traversing transversely the working edge of the crown of the tooth; the *sixth grinder is also coming into place.* At *three years and a half* or little later the adjoining deciduous incisors are shed, and their large successors begin to peep above the gum; the small lateral incisors are diminished in size and much worn. This gives a very characteristic condition to the mouth.

At *four years* the sixth grinder has attained the level of the others; the permanent tusks begin to appear; the second permanent incisors have come into place, and are marked with a deep fissure extending quite across the edge of the crown; the corresponding mark in the middle incisors is worn wider and fainter; the third deciduous grinder is shed. The external incisors are shed *between four and a half and five years.* At *five years* their permanent successors are in place, with a long deep mark on the inner side of the edge of the crown. The corresponding mark is much worn in the middle incisors, and to a less degree in the adjoining ones. The tusks are about an inch in length. At *six years* the mark or fissure on the middle incisors is worn away, but a discolouration on the part remains; the mark in the adjoining incisors is shorter, broader, and fainter; and the lateral incisors present the edges of the enamel in a more regular state, and evidently worn; the tusks are an inch in length and pointed; the third permanent grinder has taken its place in the dental series. At *seven years*

the mark is worn away on the four middle incisors in both jaws, and is in progress of obliteration in the lateral incisor; the apex of the canine or tusk is blunted. At *eight years* the mark is gone from all the lower incisors, and they cease to afford any indication of the subsequent age of the horse. The tusks are rounded off; the marks remain longer on the incisors of the upper jaw. Of course the marks are obliterated in proportion to the friction to which the teeth are subject; they are sooner lost in a stall-fed horse than in one at grass; they are prematurely worn away in the crib-biter.

The age of a horse being always calculated from the first of May, it is very difficult to determine whether the animal be a late foal of one year or an early one of the next. A horse may be made to appear older than he really is by premature extraction of the deciduous teeth: or younger by imitating artificially the natural marks of the incisors after they have been obliterated by attrition; but these frauds are readily detected when all the concomitant conditions of a horse's mouth are scanned by the practised eye.

Owing to the premature labour to which the horse is in general condemned in this country, and to the present rapid rate of travelling, he has rarely a chance of living out his natural term of existence. A well-used horse may last between thirty and forty years. Mr. Percival gives an account of a barge-horse that died in his sixty-second year. Mr. Youatt quotes the record of another horse that received a ball in his neck at the battle of Preston in 1715, and which was extracted at his death in 1758.

Era. [Æra.]

Eradicated (Lat.). In Heraldry, an epithet for a tree or flower torn up by the root.

Erased (Lat. erasus, part. of erado, *I scrape off*). In Heraldry, signifies anything forcibly torn off, leaving the edges jagged and uneven; as, a lion's head erased, &c.

Erastians. The followers of Erastus, a German divine, born 1524; a sect which obtained some notoriety in England in the time of the civil wars. They referred the punishment of all offences, civil or religious, to the civil magistrate; and asserted that the church had no power to enforce any acts of discipline, nor to refuse the communion of the Lord's Supper to anyone who desired it.

Erato (Gr.). In Mythology, the muse who presided over love poetry. (Hesiod. *Theog.* 78.)

Erbium. A metal, the oxide of which, *erbia*, is stated by Mosander to accompany yttria, but its presence has not been satisfactorily ascertained.

Erebus (Gr. Ἔρεβος). In Greek Mythology, the son of Chaos and Darkness, who dwelt in the gloomy space through which the souls passed to Hades.

Erect. In Heraldry, any animal or part of an animal which, being naturally horizontal, is placed perpendicularly.

Eremacausis (a word made up of Gr. ἠρέμα, *gently*, and καῦσις, *a burning*). A retrogressive change brought about in dead animal and vegetable matter by the chemical action of the oxygen of the atmosphere. The process is precisely the same as occurs when fuel is burnt in an ordinary fire-grate; the rapidity of the operation in the latter case, however, causes such a sensible appreciation of the evolved heat and resulting light as to necessitate another word to express the phenomena, viz. *combustion.* The term *decay* has a wider and looser application than that of eremacausis. It is used to indicate natural disintegration of any kind. Thus old walls are said to *decay*, not from any absorption of oxygen, but chiefly from the *mechanical* action of rain and frost, whilst old dead trees in decaying literally burn slowly away.

Erethismus (Gr. ἐρεθίζω, *to excite* or *irritate*). A state of great general over-excitement induced by abuse of mercury, or depressing agents. It shows a small feeble and quick pulse, præcordial sinkings, faintings, &c., and occasionally terminates suddenly in death. The tongue may be clear throughout the disease, and the secretions natural.

Ergastulum (Lat. from Gr. ἐργάζομαι, *I toil*). A workhouse, or a dwelling place for the slaves; they are described by the old Roman authors upon agriculture as dark unventilated rooms, where all kinds of cruelty were practised on the unfortunate victims.

Ergot (Fr. *a spur*). A disease of the seed of rye and other grasses, produced by the attacks of fungus, which, taking possession of the ovary, destroys it, producing in its room a long, black, hard, hornlike body. Ergot is remarkable for its specific stimulating effects upon the uterus, and is much employed in cases of difficult parturition. Hence it received the name of *Oidium abortifaciens.* It causes dangerous gangrene when taken, as it sometimes has been, among bread-corn; and as it is in some seasons extremely abundant, there can be no doubt that to it may be attributed much of the injury sustained by flocks and herds, either in the shape of gangrene, or by causing them to slip their young. [Ergotism.]

Ergotin. The acrid bitter active principle of ergot.

Ergotism. The condition produced in those who partake of ergotised or diseased rye as an article of food. The symptoms occurring from ingestion of this poison in small and continuous doses are of very marked character. The disease has been called by various names. We have adopted the French name, while the Germans call the disease the Krieblekrankheit or creeping sickness. Nearly every part of the Continent has suffered at some time or other from ergotism, appearing as an epidemic. It attacks persons of both sexes and of all ages. The disease is divided into two forms, viz. *convulsive* and *gangrenous* ergotism.

The first is characterised by marked head symptoms, such as vertigo, weariness, partial loss of sight and of sensibility, formication, contraction of the muscles of the extremities, and

partial jaundice. In the early stage the appetite is voracious; but the severer symptoms soon supervene, and death occurs by convulsion. In the gangrenous form the appetite is voracious, and the sense of formication is also observed as in the convulsive form of the disease. The extremities then become colder than in their natural state, and gangrene sets in. Ergotism was probably known long before the cause was detected, for we find the following curious passage in the works of Sigebert about the year 1089: 'A pestilent year, especially in the western parts of Lorraine, where many persons became putrid in consequence of their inward parts being consumed by St. Anthony's fire. Their limbs were rotten, and became black like coal. They either perished miserably, or, deprived of their putrid hands and feet, were reserved for a more miserable life.' Ergotised rye is used medicinally in several forms of disease, but more especially to increase the expulsatory efforts of the womb in protracted labours, and to restrain uterine hæmorrhage. In cases of poisoning by a large dose of ergot, the symptoms are nausea, dryness of throat, pain in the abdomen, stupor and dilated pupil. In pregnant females abortion occurs.

Ericaceæ (Erica, one of the genera). A natural order of shrubby hypogynous Exogens, inhabiting the Cape of Good Hope and many other places. It differs from *Vacciniaceæ* and *Campanulaceæ* in the superior ovary; from *Epacridaceæ* in the anther being two-celled; from *Pyrolaceæ* and *Monotropaceæ* in the structure of the seeds, and in habit; and from all the orders represented by *Scrophulariaceæ* and *Gentianaceæ* in the number of the cells of the ovary agreeing with the lobes of the calyx and corolla. Their general qualities are astringent and diuretic, some few being poisonous. The *Arbutus*, *Andromeda*, *Kalmia*, *Rhododendron*, *Azalea*, all well-known shrubby plants of great beauty, belong to this order.

Erichthians. [ERICHTHUS.]

Erichthus. A genus of long-tailed Decapod Crustaceans, inhabiting the tropical ocean. These crustacea are remarkable for the delicate and often transparent and colourless character of their large and undivided thoracic shield or carapace, which is always terminated anteriorly in a styliform rostrum: they have no movable rostral plate, and the gills are in general very small and simple, and sometimes wholly inconspicuous. The genus thus characterised is now subdivided into *Squillerichthus*, *Almia*, and *Erichthus* proper; and the whole are included under the family name of *Erichthians*, or *Erichthidæ*, which in the natural system ranks next to the *Squillidæ*, or sea mantises.

Eridanus (Lat.). In Astronomy, one of the ancient constellations in the southern hemisphere, first mentioned by Aratus.

Erinaceus (Lat. *a hedgehog*). A genus of useful insectivorous Mammals, of which our common hedgehog is a well-known and undeservedly persecuted species. The teeth are small, and form a series of sharp bristling points, well adapted for the crushing of beetles, or cracking the backbone of a snake; but quite inadequate to the purpose of self-defence against larger carnivorous quadrupeds. Nature has, however, provided the hedgehog with a coat of armour, thickly bristled over with strong elastic spines, and capable of being drawn by powerful cutaneous muscles over every part of the body. When the hedgehog thus puts himself in a defensive attitude, he resembles a bristled sphere; and is capable of enduring hard blows or heavy falls without suffering material injury.

As the food of the hedgehog consists almost wholly of cold-blooded animals, which in our climate almost entirely disappear from the scene of nature in the winter season, the hedgehog must have starved if he had not been endowed with the singular property of subsiding into a state of suspended animation during the period of famine. In order, however, to preserve the low temperature which he then possesses, he prepares in some retired hole a soft nest of moss and leaves; and thus passes his winter. All the store of nutriment which he carries with him to his place of hibernation is a thick layer of fat about his viscera and beneath his skin, which is slowly absorbed, as the little waste of his inactive life requires, and more rapidly during the first few days of his resuscitation in spring. The female produces from two to four young ones in the summer; they are blind, and covered with soft and flexible spines. The hedgehog has thirty-six teeth. The intermaxillary bones contain six teeth, of which the two anterior are longer than the rest, placed wide apart, directed obliquely downwards with a slight convergence. The six upper incisors are opposed to six below, of which the two anterior ones have the same disproportionate size as the corresponding ones above. Of the remaining teeth, the four posterior ones on each side of both jaws are large, multicuspidate, true molares. The intermediate teeth are small, with two fangs, and represent the spurious molares.

Erinys, less correctly **Erinnys** (Gr. ἐριννύς). In the mythology of Æschylus, the Erinyes are invisible beings who execute judgment on those who have shed blood. Thus the Erinyes of Clytæmnestra haunt Orestes, until he is delivered from them by the verdict of the Athenian Areopagus. But these personal attributes do not belong to them in the Vedic mythology, where Erinys appears under the name Saranyû, as the fresh and early *dawn*. The transition is easily explained. The original phrase applied to the guilty was, 'Saranyû [the light] will find out your sin;' and as soon as Erinys became a person, she would naturally be invested in sombre and gloomy colours.

Eriobotrya (Gr. ἔριον, *wool*, and βότρυς, *a bunch*). The Loquat or Japanese Medlar, *E. japonica*, is the principal plant of this genus of *Pomaceæ*. It is an evergreen, with terminal spikes of flowers succeeded by oval pale orange

fruit of the size of a small apple, and having a sharp subacid flavour. It blossoms too early to be grown as a fruit outdoors in this country, and is hardly worth house culture; but in warmer countries, as at Malta, it succeeds admirably. It is cultivated in many parts of India, as well as in China and Japan. In warm countries its subacid fruit is grateful to the palate.

Eriocaulaceæ (Eriocaulon, one of the genera). A natural order of Endogens, of the Glumal alliance, inhabiting the marshes of most parts of the world: usually combined with *Restiaceæ*. It is composed of herbaceous plants, with cellular spongy leaves, and flowers growing in close heads; it contains no species of any known use. Some of the *Eriocaulons* of Brazil grow six feet high.

Eriometer (Gr. ἔριον, *wool*, and μέτρον, *a measure*). An optical instrument for measuring the diameters of minute particles and fibres, by ascertaining the diameter of any one of the series of coloured rings which they produce. 'The eriometer is formed of a piece of card or a plate of brass, having an aperture of about a fiftieth of an inch in diameter in the centre of a circle about half an inch in diameter, and perforated with about eight small holes. The fibres or particles to be measured are fixed in a slider; and the eriometer being placed before a strong light, and the eye assisted by a lens applied behind the small hole, the rings of colours will be seen. The slider must then be drawn out or pushed in till the limit of the first red and green ring (the one selected by Dr. Young) coincides with the circle of perforations, and the index will then show on the scale the size of the particles or fibres.' (Brewster's *Optics*, *Cabinet Cyclopædia*.)

Eriphia (Gr. ἔριφος). A genus of short-tailed or Brachyurous Crustaceans, including the *Cancer spinifrons*, Herbst.; *Cancer conagra*, Fabr.; and other later discovered species.

Eris (Gr. *strife*). In the Homeric and Hesiodic mythology, a daughter of Nyx, the night, and sister of Ares. In the myth of Paris and Œnonê, it is Eris who throws the golden apple, inscribed as a gift for the fairest, on the banquet table of the gods who were celebrating the wedding feast of Peleus and Thetis. Eris is introduced into the Roman mythology under the name Discordia.

Erisma (Gr. *a cause of quarrel*, from its *variance* with others of its family). The name of a genus of *Vochyaceæ* found in tropical America. One of the species, *E. Japura*, is the Japura of Brazil, a tree growing to the height of 100 feet or more, and bearing a red fruit, the kernel of which is eaten raw or boiled. The kernels are also prepared by being boiled from morning to night, then well covered up and put for two or three weeks into baskets in running water, where they acquire a disagreeable stercoraceous odour; they are then beaten up in a mortar till they acquire the consistence of pale butter, and in this state placed in cylindrical baskets of palm stems. Japura butter, kept dry by being placed on a stage over the fire, will remain good for two or three years, and is used in gravies. It retains a vile smell, but is said to be savoury.

Ermine. In Heraldry, one of the furs used in blazonry. It represents the skin of that animal white, spotted or timbered with black. *Ermines* is black, spotted or timbered with white. *Erminites* differs from ermine in having the side hairs of the timberings red. *Erminois* is the same as ermine, except that gold is substituted for the white. *Pean* is black, timbered with gold.

Ermine. ('This,' says Gwillim, 'is a little beast less than a squirrel, that hath his being in the woods of the land of *Armenia*, whereof he taketh his name.') In Zoology, a species of *Mustela*, or stoat, differing from the common weasel in being about one-third larger, and in having a somewhat broader head and a longer tail. In the summer season the upper part of the head, neck, and body, and the greater part of the tail, are of a pale reddish-brown colour; the under parts white, with a very slight tinge of yellow; tip of the tail black, and somewhat bushy. In the winter the whole of the body becomes white, slightly tinged with yellow; but the black termination of the tail is permanent. The fur is closer and finer at this season, especially in the colder latitudes, from which countries the ermine affords one of the most beautiful and valuable of furs. When made up the tails are inserted one to each skin, at regular distances, and in the quincunx order; and thus arranged the ermine fur forms the distinctive doubling of the state robes of sovereigns and nobles, as well as of their crowns and coronets.

Erminois. In Heraldry, a fur in which the field is gold, and the spots or tufts black.

Eroded (Lat. erodo, *I gnaw off*). In Zoology, when a part has its edges irregularly jagged, as if gnawed or eaten.

Eros (Gr. ἔρως, *love*). In Greek mythology, the god of love. In Hesiod, Eros is one of the great cosmogonic powers, along with Chaos, Gæa, and Tartarus. Later poets describe him variously as a son of Hermes and Ares, of Artemis and Aphrodite. His chief characteristic is youthfulness and the power of inspiring the passion of love. In the Veda, Eros appears under the name Arusha, one of the most frequent epithets or names of the sun; but, as in the Greek mythology, Arusha is represented as a child. He is the young sun, driving away the dark night, and awakening the earth with his rays, which later poets converted into arrows, like the lances of Phœbus and Heracles. (Max Müller, 'Comparative Mythology,' in *Oxford Essays* for 1856.)

Erose (Lat. erosus, *eaten away*). In Botany, having the edges irregularly jagged.

Erotic (Gr. ἐρωτικός, from ἔρως, *love*). An epithet applied generally to all that relates to or excites the passion of love. In a more confined sense, this appellation has been conferred on a certain class of Greek and Latin

authors, both in prose and poetry, of whose writings love formed the principal theme. Of these the most distinguished are Achilles Tatius, Heliodorus, Anacreon, Sappho, Ovid, Tibullus, Propertius, &c.

Erotomania (Gr. ἔρως, and μανία, *madness*). Mental aberration, supposed to be occasioned by the passion of love.

Erpetology. [HERPETOLOGY.]

Erpeton. [HERPETON.]

Errata (Lat.). In Printing, the faults that have escaped in the impression, or, as the case may be, in the composition of a work; usually inserted in a list either at the commencement or the end of the book. This manner of indicating typographical errors is coeval with the art of printing itself. Various dissertations have been devoted to this subject; among others may be mentioned that of Lindenberg, *De Erroribus Typographicis*, which, although of a somewhat impracticable nature, contains many ingenious observations.

Errhines (Gr. ἔρρινον, from ῥίς, *the nose*). Remedies which induce an increased secretion of nasal mucus. When this is accompanied by sneezing, they are called *sternutatories*. They are principally used to relieve chronic affections of the eyes, face, and brain, and are perhaps useful on the principle of counter-irritation. [SNUFF.]

Error. In Law, a writ of error is one which authorises the judges of a superior court to examine a record on which judgment has been given in an inferior court on an allegation of error in pleading a process, &c., and to affirm or reverse the same. It is the common remedy for erroneous judgments in courts of record. Error lies from inferior courts of record, and from the Common Pleas, to the King's Bench; from each of the three superior courts to the judges of the other two sitting in the Exchequer Chamber; from the Exchequer Chamber, and in certain cases directly, to the House of Lords. It lies in criminal as well as civil cases. Writ of error must be brought within twenty years. Correctly speaking, it is applicable only for the reversal of judgments on account of errors in law, and not of fact.

Erse. The name given by the English and Scots to the dialect of Celtic spoken by the inhabitants of the Highlands of Scotland. The term is evidently another form of the word Irish. The people speaking the Erse tongue call themselves *Gael* (written, but not pronounced, *Gaidheal*), and their language *Gaelig*. England in the Erse language is called *Sasson*, meaning Saxony, and the people and language *Sassenach*; the latter being often called *Beurla*, which means speech in general, and in this case 'the language' *par excellence*. The Irish are called by the Scots Highlanders *Gael*, like themselves, with the distinction of belonging to Erin, or Ireland. For the Welsh and their country there appear to be no names known to the Erse language. The Erse or Gaelic has been asserted to be one of the dialects of that Celtic or Gaulish class of languages which once pervaded nearly the whole Western portion of Europe, including France, Spain, and Britain, as spoken by the Celtic or first division of the Aryan race which reached Europe. (Max Müller's *Lectures on Language*, 185.)

The only remaining dialects of the Celtic are the Kymric and the Gadhelic or Gaelic, the former comprising the Welsh, Cornish (lately extinct), and the Armorican; the latter, the Erse of Ireland and Scotland, and the Manx dialect of the Isle of Man. These languages agree respectively with each other, not only in grammatical structure, but in that numerous class of words which constitutes the groundwork of every language; viz. prepositions, adverbs, conjunctions, with such verbs, adjectives, and nouns as are of most frequent and familiar use. The Irish and Erse so nearly resemble each other, that after a short familiarity with the pronunciation, the Irish and Scots Highlanders have no difficulty in understanding each other; and the same is said to be the case with the Welsh and the Bas Breton. The Manx is but a dialect of the Irish or Erse, and the now extinct Cornish was unquestionably a dialect of the Welsh. As to the Basque, long supposed to be a Celtic tongue, a careful examination of it by William von Humboldt showed not only that it bore no resemblance to the Welsh, the Irish, or their dialects, but that it had nothing in common with any known language, ancient or modern.

Of the Celtic languages, the Welsh appears to be that which was most cultivated. It was unquestionably a written language in the tenth century; and the perfect alphabet, by which every sound in it is invariably expressed, consisting of sixteen radical and twenty-seven derivative characters, forming in all forty-three letters, is still preserved. The Erse or Gaelic was the least cultivated; and until late years even the Bible which was used in the Highland churches was no other than the Irish. It first attracted notice after the publication in the English language of the poems of Ossian, said to be derived from it, about the middle of the last century. These, it was pretended, were translated from manuscripts in the translator's possession; but such poems in a written form, it is now sufficiently known, never had any existence, either in the Irish or Gaelic language. Although not reduced to writing, or rather not handed down in writing, these poems, committed to memory and thus transmitted from one bard or story-teller to another, still exist in the Highlands of Scotland, and in a dress not unlike that in which they were rendered by Macpherson into English. Their scene is sometimes laid in Scotland, but more frequently in Ireland. In short, they are the *Iliad* and *Odyssey* of the Celtic race of the two islands, handed down by tradition only—what the poems of Homer were to the Greeks themselves, before the art of writing was known to them. The Erse, although a rude and uncultivated language, is a nervous and manly one, both as

to expression and sound, and well suited to poetry, whether sublime or tender. The range of its sounds is very great; for it possesses twelve vowels, and no less than eighteen diphthongs and triphthongs, with forty-one consonants, including aspirates. Many of the consonants are guttural; and of these, as well as of the vocalic sounds, there are several utterly unpronounceable by a stranger: the attempts made to express such a variety of sounds by the Roman alphabet are, of course, both awkward and imperfect. On the affinity of the Celtic to the Teutonic and other classes of the Aryan family of languages, see Max Müller's *Lectures on the Science of Language.*

Erucic Acid (Lat. eruca, a plant supposed by some to be *white mustard*). A colourless crystalline body contained in expressed oil of mustard.

Ervum (Lat.; Gr. ὄροβος). A family of *Leguminosæ*, chiefly remarkable as containing the Lentil, *E. Lens*, an annual with weak branching stems, bearing smooth pods containing a few roundish compressed seeds. These seeds are the Lentils of commerce, much used for food in many parts of the East as well as in Central and Southern Europe. Lentil powder is nutritious, and is said to be beneficial in some cases of indigestion.

Eryngium (Gr. ἤρυγγος, *sea-holly*). The genus of Umbellifers which yields the Sea Eryngo, *E. maritimum*, a seashore plant with glaucous holly-like leaves, and thistle-like heads of blue flowers. Its fleshy roots are candied, and had once a medical reputation.

Erysipelas (in the opinion of some, from the Gr. ἐρύεσθαι, *to search*, and πέλας, *near*—spreading over the neighbouring parts; but this is doubtful). Called also *St. Anthony's Fire*, that saint having miraculously cured it. This disease usually commences with fever and vomiting, followed by an eruption of a red colour, sometimes vesicular, and attended by tumefaction. It commonly attacks the head and face, and is at its height from the third to the sixth day; but its duration and progress are very variable in different individuals. The fever which attends this form of erysipelas is sometimes inflammatory, and at first cooling diet and aperients are required; the local irritation and itching may be quelled by sprinkling the part with a puff of hair powder (starch), which is singularly soothing to the sufferer. From the eighth to the twelfth day, the eruption scabs or scales off. If sickness, shiverings, and delirium attend the height of the disorder, an unfavourable termination may be anticipated. Sometimes suppuration occurs, especially of the eyelids and scalp. The greater number of cases of this disorder have a tendency to debility; and wine, bark, or sulphate of quinia, with other tonics, are indicated.

Where erysipelas is attended with typhoid symptoms, it is dangerous from the beginning; and wine, bark, ammonia, brandy, and other stimulants, are usually prescribed.

In that form of erysipelas which attacks different parts of the body in successive patches, aperients, diaphoretics, and alteratives are useful; but in every case of this disease, lotions and ointments should be used with the utmost caution. There is a variety of erysipelas which attacks infants, and which is sometimes alarming from its gangrenous or suppurative tendency. Erysipelatous inflammation is also often a sequel of surgical operations, especially in crowded and ill-ventilated hospitals, where it sometimes spreads among the patients to a very alarming extent. Cleanliness, ventilation, fumigation, and, above all, the removal of the affected persons to a better air, are the only chances of eradication.

Erythema (Gr. ἐρύθημα, *redness*). A redness of the skin, generally observed in patches, and sometimes attended with puffiness of the parts affected. It is not attended with febrile symptoms of any consequence, except in a form described as *erythema nodosum*, which is characterised by elevated and somewhat indurated nodules of a red colour rising on the legs, and sometimes on the arms. These generally are more or less oval in shape. The onset of this form is marked by febrile excitement. The treatment consists in the exhibition of purgatives, tonics, and alteratives. Quinia is especially valuable. Ordinary erythema rarely gives trouble, subsiding gradually under mild alterative treatment and rest.

Erythric Acid (Gr. ἐρυθρός). Applied by Brugnatelli to the *red* substance obtained by the action of nitric on uric acid.

Erythrine (Gr. ἐρυθρός). One of a series of substances obtained from the *Roccella tinctoria*, a lichen which furnishes the blue dyestuff called *litmus*.

Erythrogen. A peculiar substance, discovered in 1821, by M. Bizio of Venice, in the gall-bladder of a person who died of jaundice. It was a green tasteless liquid, which became *deep purple* in nitric acid and ammonia, and when heated in the air produced a purple vapour.

Erythronium (Gr. ἐρυθρός). A name originally given to the metal since called *Vanadium*, from the *red* colour of its acid.

Erythrophyll (Gr. ἐρυθρός, and φύλλον, *a leaf*). A substance to which the autumnal reddish tint of some leaves is due.

Erythroxylaceæ (Erythroxylon, one of the genera). A natural order of Exogens belonging to the Sapindal alliance. The most remarkable plant it contains is the Coca, *Erythroxylon Coca*, common through part of Peru, Quito, and New Grenada, and also on the banks of the Rio Negro, where it is called *Spadic*. This plant is used as a sedative.

Eryx. A genus of serpents with a short obtuse tail and a single series of subcaudal scutæ, as in Boa; but having both the abdominal and caudal scutæ much narrower, and the anal hooks inconspicuous.

Escalade (Fr. from Lat. scala, *a stair*). The scaling of a fortification by means of ladders is so called.

Escalloniaceæ (Escallonia, one of the genera). A small natural order of Exogens belonging to the Grossal alliance, and especially distinguished by its imbricated calyx, its definite style, and its capsular fruit with axile placentæ. It yields some ornamental shrubby species.

Escalop. In Heraldry, the scallop-shell used to decorate palmers on their way to and from Palestine.

Escape. In Law, from legal restraint, is either in civil or criminal cases. The former (out of the custody of the sheriff, who has the restraint of the persons of debtors) is either voluntary (by the sheriff's consent, who then cannot retake and becomes himself liable) or through negligence. In criminal cases, the escape of a person lawfully arrested is punishable by fine and imprisonment, both of the person himself and those who may assist him. An escape-warrant is a process addressed to the sheriff to retake an escaped prisoner.

Escapement. In Clock and Watch work, the name given to that part of the mechanism by which the circulating motion of the wheels is converted into a vibratory motion, as that of the pendulum of a clock or balance of a watch. Various contrivances are employed for this purpose, depending on different mechanical principles, as the *dead-beat* escapement, the *lever* escapement, the *duplex* escapement, the *detached* escapement, &c. [Horology.]

Escarp (Fr. escarpe, Ger. scharf, *sharp*). In Fortification, the side of the ditch next the place; in which case it is opposed to *counterscarp*, which is the side next the country. In a fortress, the escarp is generally revetted with masonry.

Escarpment. In Geology, the steep face often presented by the abrupt termination of strata where subjacent beds *crop out* from under them. The two most extensive lines of hill which traverse the centre and south of England are formed by the escarpments of the oolite and chalk formations respectively. The first extends through Yorkshire, the West of Lincolnshire, Rutland, Northampton, Warwick, Gloucester, Somerset, Dorset; being bounded throughout on the north-west by the outcrop of the *lias* formation. The latter commences in Yorkshire, rises again in Norfolk, and extends through Cambridge, Hertford, Bucks, Oxford, Berks, Wilts, and Dorset, in a parallel line to the former.

Eschalot (Fr. échalote). In Gardening, a small kind of onion, *Allium ascalonicum*, commonly called *Shallot*.

Eschar (Gr. ἐσχάρα, in the sense of *the crust of a scar produced by burning*). When a living part has been burnt, it becomes hard, rough, and of a grey colour, forming what is properly called an *eschar*: it is a slough produced by fire or caustics. The English *scar* is evidently derived from this term.

Escharotics (Gr. ἐσχάρα). Applications which form eschars. The term is generally applied in Surgery to mild caustics.

Escheat (Nor. Fr. escheate, *succession*, from Lat. cadere, *to fall*). In Law, happens when tenant in fee simple dies without having left any heir to the land, and without having incurred a forfeiture to the crown (as for treason). This case arises on sentence of death for murder; but not for other felonies, which, since 54 Geo. III. c. 145, leave the power of disposition of his estate after death to the offender. There is no escheat of equitable estates. In practice it is common for the crown, under advice of the Lords of the Treasury, to make voluntary grant of lands escheated or forfeited to relatives of the deceased.

Esclatte. In Heraldry, anything shattered by the stroke of a battle-axe.

Escrow (Fr. escroue, A.-Sax. schrowe). In Law, a deed delivered to a third party, to be the deed of the party making it upon a future condition when a certain thing is performed, until which it has no effect as a deed.

Escuage or **Scutage** (from Lat. scutum, *a shield*, the piece of money so called having derived its name from this tribute). A pecuniary satisfaction, paid in lieu of military service by tenants in chivalry. There have been doubts among our antiquarian lawyers whether escuage were, properly speaking, a tenure in itself, or merely an incident to tenure; but the latter is probably its proper character. Littleton says, that tenant by homage, fealty, and escuage is tenant by knight service. The assessment of escuage was uncertain in amount, and, by Magna Charta and 25 Edw. I., could only be taken by assent of parliament. Escuage, together with the other appendages of military tenures, was abolished by 12 Ch. II. c. 24.

Esculic Acid. [Saponic Acid.]

Esculin. *Polychrome.* A neutral crystalline substance found in horse-chestnut bark. It possesses the property of *fluorescence* in a high degree; one part in a million parts of water appearing blue by reflected light.

Escurial (Span. Escorial). A royal palace of Spain, about twenty-two miles from Madrid, at the foot of the mountains which divide the two Castilles. Its foundations were laid by Philip II. in 1563; Juan Bautista of Toledo being the architect who designed, and continued to superintend, the building till his death in 1567, when his pupil Juan de Herrera carried it on, being assisted by Antonio de Villacastin. It is considered by Spaniards as the eighth wonder of the world, and numberless fables are told about the domes, windows and columns, which are said to be innumerable; as well as its cost, which is said to have been twenty-four millions of ducats; but this is much exaggerated, as it cost only about a quarter of that sum. The whole pile comprises a magnificent monastery, which was given to the fathers of St. Girolamo, a college, a seminary, and a royal palace. It is internally disposed into fifteen courts of various dimensions, the largest being ornamented with porticoes and galleries; the material employed is a species of granite which the Spanish masons

work with surprising dexterity. The principal façade, looking towards the west, is 740 feet long, and 70 feet high to the cornice; and at the extremities are erected towers 200 feet high. From the centre of the church a cupola rises, of a good form externally, but clumsily composed inside; its diameter is 66 feet from the pavement to the top of the cross, the height 330 feet. The burial-place for the Spanish royal family is called the Pantheon, and is the crypt under the chapel, situated immediately below the high altar. On the two inferior landings of the staircase which leads to it are two doors, one leading to the vault where are laid the remains of the infants and infantas, and of the queens who have had no issue; the other to the chamber, 36 feet diameter and 38 feet high, where the remains of the kings are deposited. The whole of the building is profusely ornamented, particularly with paintings by the best masters of Italy, Flanders, Spain and Germany. Attached to the monastery by an arched doorway is an edifice called the Campana, which has two galleries, each of them 100 feet long and 20 feet wide. This was built by Francesco de Mora, the third architect who succeeded Juan de Herrera. Here are the hospitals, granaries, pantries, and other offices, with the gardens. Adjoining the eastern and northern façades is a spacious gallery or esplanade, surrounded by a parapet; on this side are the quarters for the guards, the riding school, the aqueduct, &c. &c. In 1773 many works were executed at the Escurial, for the infantas Don Antonio and Don Gabrielo, by Villanueva, the then architect of the palace; indeed, all the successors of Philip II. have made additions to this superb edifice, which exhibits with great beauties great defects. (See the *Descripcion del Real Monasterio de San Lorenzo del Escurial*, by Fray Andres Vimenes, which has been translated into English by Thompson; and Mr. Fergusson's criticisms in his *History of Modern Architecture.*)

Escutcheon or **Escocheon** (Old. Fr. escusson, dim. of escu, Ital. scudo, Lat. scutum, *a shield*). In Heraldry, a shield on which arms are emblazoned: derived from the French écu or écusson, Italian scudo, Latin scutum. The favourite shape for the purpose of heraldry is that commonly called the Norman shield; but women, daughters of parents entitled to coat-armour, bear their father's arms on a lozenge-shaped shield. The points of the escutcheon are the parts named in order to express the local position of the charges borne on the field. [CHARGE.] They are nine in number. *Escutcheon of pretence* is the shield on which a man carries the arms of his wife; in England only borne if she is an heiress, and he has children by her. It is borne in the centre of his own shield, and generally of the same shape. *Inescutcheon*, an escutcheon borne also within the shield in the middle of the coat (but smaller than an escutcheon of pretence), or in chief. It is a species of ordinary.

Esmarkite. A species of Datholite, or borosilicate of lime, discovered by Esmark at Arendal.

Esocidae (Lat. esox, *the pike*). The *Pike tribe*, a family of *Malacopterygious* or soft-spined fishes, having the ventral fins placed under the abdomen, and including most of the voracious fresh-water fishes, as well as several marine species.

Esoteric (Gr. *ἐσωτερικός, inner*), opposed to *Exoteric* (Gr. *ἐξωτερικός, outer*). Much dispute has prevailed among the learned as to the precise import of this distinction. By some it was thought that the ancient philosophers had a set of mysterious doctrines which they communicated only to the more enlightened of their disciples, and another more popular doctrine which they promulged to the multitude. In the case of Aristotle, to whose writings the distinction is properly applied, this opinion is, to a certain extent, well founded; except so far as regards the suspicion of intentional concealment implied in it. The exoteric or *published* writings of that philosopher appear to have been written in the form of dialogues, all of which are lost. His esoteric works, we gather from the synonymous term *acroamatic*, were not intended to supersede the necessity of oral instruction to render them intelligible. This agrees well enough with the brevity, the frequent repetitions, and the perplexed arrangement of the works of Aristotle which survive. [ACROAMATIC.]

Espalier (Fr. from palis, *a pale* or *pole*). In Horticulture, a substitute for a wall on which to train fruit-trees, and sometimes ornamental shrubs. The objects are to expose the foliage of the plants more perfectly to the light, to prevent the branches from being blown about by the winds, and to economise space by confining them within definite limits. The espalier is either constructed of wood or iron; and commonly of two horizontal rails joined by upright rods, six or eight inches apart.

Esparto (Span.). A species of grass, the *Stipa* or *Macrochloa tenacissima*, found in the southern provinces of Spain. It is made into cordage, much used in the Spanish navy; and is plaited for other purposes, such as mats, shoes, &c. Spanish grass is now largely imported into Great Britain for making paper.

Esplanade (Fr.). In Fortification, an open space of ground left outside the glacis of a work to prevent an enemy erecting breaching batteries under cover of buildings.

Espousals (Lat. sponsalia). In Law, a contract of marriage. [MARRIAGE.]

Esquire, Ecuyer, Escudero. A well-known title of rank; derived from the Fr. écu, escu, Lat. scutum, *a shield*. Some suppose that it has its origin from the scutarii, a sort of soldiery in the Roman armies; others derive it from equus, *a horse*, and suppose that esquire and equerry denoted originally the same thing, viz. *a groom*. But it is generally supposed to have belonged to the shield or armour bearers (armigeri) attached to the person of knights

This office, in the times of chivalry, was honourable, and generally borne by persons of good family. Hence the term *esquire* became gradually appropriated, in England, to a rank above the simple gentleman and below the knight. Younger sons of peers (now called *honourables*), their eldest sons, eldest sons of knights, sheriffs of counties, serjeants at law, justices of the peace, and doctors of divinity, are esquires by virtue of their respective rank or office. Heads of ancient families are considered esquires by prescription; and hence has originated the use of the word, in the present day, as a common addition to the names of all those who live in the rank of gentlemen. According to ancient usage, the king created an esquire, by putting round his neck a silver collar of *ſſ*; to which ceremony was added the putting on of a pair of silver spurs.

Essay (Fr. essai). In Literature, an attempt; a species of composition. In general, this title is given to short disquisitions on subjects of taste, philosophy, or common life. In this sense it has been applied to periodical papers, published at regular intervals under a collective name, by one or more writers, containing remarks on topics of the day or on more serious subjects. From the appearance of the *Tatler*, in the beginning of the last century, which was chiefly written by Sir Richard Steele, this species of literature continued to be a favourite in England for seventy years, and many similar series of essays were produced: the best of which are united in one collection under the name of *The English Essayists*. The most celebrated of these works was the *Spectator*, to which Addison was the best contributor; and next to it the *Rambler*, published and almost wholly written by Samuel Johnson. The title of *essay* has been also adopted, by way of indicating diffidence in the completeness of their work, by various authors of more extended performances; as by Locke (*Essay on the Human Understanding*).

Essence (Lat. essentia, from esse, *to be or exist*). In Philosophy, a scholastic term, denoting what the Platonists called the idea of a species. The school philosophers give two significations of the word *essence*: the first denoting the whole essential perfection of a being, and consequently its entity, with all its intrinsic and necessary attributes taken together; the second denoting the principal or most important attributes of any thing. The essences of things were held by many to be uncreated, eternal, and immutable. [METAPHYSICS.]

Essence d'Orient (Fr.). A term applied to a pearly-looking matter found principally at the base of the scales of the *bleak*, a small fish of the genus *Cyprinus*: it is used to line the interior of glass bubbles or beads, as in the manufacture of artificial pearls.

Essenes. A sect among the Jews in the time of our Saviour, of whom an account is preserved to us by Josephus and Philo, though they are not mentioned in Scripture. They were few in number, and lived chiefly in solitude, taking no part in public affairs, but devoting their lives to contemplation. There were indeed two classes of them, distinguished as the practical and contemplative, who differed in the degree of strictness and austerity which they observed. They believed in the immortality of the soul, and held the Scripture in the highest reverence, interpreting it after an allegorical system of their own. The whole subject, however, is involved in such obscurity, that De Quincey was able with some plausibility to propound the theory that the so-called Essenes were in reality the Christian community.

Essential Oils. The essential or volatile oils may be regarded as the odorous principles of vegetables, and are generally obtained by distilling the plant with water, either in its fresh, salted, or dried state. In some cases they are pressed out of the cellular structure, as from orange and lemon peel. They are obtained from all parts of plants, though usually most abundant in the leaves and flowers; and they sometimes differ in different parts of the same plant: thus, in the orange-tree, the leaves, flowers, and fruit, each yield a distinct oil. Some of them are so delicate and evanescent as to require a peculiar mode of treatment, such as those of the flowers of jasmine, tuberose, narcissus, mignonette, &c. These flowers are stratified with layers of cotton, or wool, imbued with some inodorous fixed oil, which absorbs the perfume of the flowers. When the fixed oil is saturated with the perfume, it is digested in alcohol, which abstracts the essential from the fixed oil, and an odoriferous *essence* is obtained. Sometimes the cotton is distilled with water or alcohol to separate the odorous essence; but the fragrance is always more or less impaired by these processes.

The essential oils are applied to many useful purposes: some in the manufacture of paints and varnishes, some for burning in lamps; others in pharmacy and medicine, and others in perfumery. They are mostly ready formed in the plant, but they are in some cases generated by the action of water upon peculiar principles, as in the production of bitter-almond oil; and there are a few instances of their artificial production, as in that of *oil of spiræa*, by the oxidation of salicine. When fresh and pure, these oils are mostly colourless or nearly so; a few are green or blue, and some after having acquired colour, lose it under the influence of light. Their odours resemble those of the plants yielding them, but are less agreeable, partly in consequence of concentration, for they become more pleasant when diffused in the air, or when attenuated by solution in some inodorous vehicle; they are also influenced by their chemical relations to air and water. Some oils, such as those of turpentine, lemons, and juniper, when distilled off quicklime, out of contact of air, are nearly inodorous, but which acquire their characteristic odours when spread upon paper.

The specific gravity of the essential oils fluctuates between 0·840 and 1·100, and when subjected to a careful fractional distillation, they are mostly resolvable into products differing in specific gravity and in composition; one of which is frequently a *hydrocarbon*, and the other an *oxyhydrocarbon*, which is sometimes concrete, constituting a species of *camphor*. The terms *elaioptene* and *stearoptene* have been applied to these liquid and solid products (from ἔλαιον, *oil*, or στέαρ, *fat*, and πτηνός, *volatile*). Their boiling points are variable, and so are the temperatures at which they congeal, these being often dependent upon the relative proportions of their component oils. They are sparingly soluble in water, to which, as in the medicated waters of the *Pharmacopœia*, they communicate odour and flavour; most of them are copiously soluble in absolute alcohol and in ether, and in fixed oils and liquid hydrocarbons. In consequence of the high price of many of these oils, they are sometimes adulterated with alcohol, with fixed oils, or with cheaper essential oils. *Alcohol* may generally be separated by shaking the adulterated oil with water, and its quantity appreciated by the diminution in the bulk of the original oil. Moreover, the pure volatile oils dissolve, for the most part, in the fixed oils, without interfering with their transparency; but when adulterated with alcohol they produce turbidness. The admixture of a *fixed oil* is shown by the greasy stain which remains on evaporating a drop of the oil before the fire, from a piece of blotting-paper: some of the genuine oils leave a stain, but it is rather resinous than greasy, and admits of being written upon with a pen and ink, or removed by alcohol. The feel of the adulterated oil between the finger and thumb is also greasy, and when it is distilled with water, the fixed oil remains in the retort. The adulteration of a *high-priced* with a *cheap* essential oil is often difficult of detection, and requires experience in the odour and qualities of the genuine article. When oil of turpentine is so used, its characteristic odour is often covered, until the adulterated oil is dissolved in a little alcohol, and water added, when the odour and flavour of the turpentine are manifest. The difference between the indices of refraction of the adulterated and genuine oils has been proposed as a means of detecting falsifications, and Dr. Wollaston suggested an instrument for the purpose (*Phil. Trans.* 1802); but the refractive powers of the genuine oils vary too much to render this method satisfactorily available.

For the purpose of chemical description, the essential oils may be arranged under three divisions: 1. Those composed of carbon and hydrogen; 2. of carbon, hydrogen, and oxygen; 3. those containing sulphur.

1. Hydrocarbons.—The elementary composition of this group may be represented by C_5H_4; it includes many isomeric compounds, of which *oil of turpentine* may be assumed as the type. *Oil of turpentine* $C_{20}H_{16}$ (*camphene*; *camphyle*) is obtained by distilling the turpentine of commerce with water. It is a colourless and very mobile liquid; specific gravity 0·865, boiling at 312°, and yielding a vapour of the density of 4·764. It has a characteristic odour, a hot pungent taste, and burns with a large sooty flame: it is almost insoluble in water, but soluble to some extent in alcohol and in ether. Under the name of *camphene* it was at one time largely used as a source of light, and when carefully burnt in a properly constructed lamp, gives a brilliant flame; but if the oil is not fresh, and has been exposed to air, it clogs the wick, and smokes. Its use has lately been superseded by *rock-oil* and other modifications of naphtha.

2. Oxyhydrocarbons.—The *essential oils containing oxygen* are very numerous. Some of them, when distilled, are separable into a more volatile hydrocarbon and a less volatile oxyhydrocarbon. *Oil of cumin*, for instance, may be resolved into a hydrocarbon $= C_{20}H_{14}$, *cymol*, and an oxyhydrocarbon $= C_{20}, H_{12}, O_2$, *cuminol*. *Oil of aniseed* is similarly separable into a hydrocarbon and an oxyhydrocarbon.

3. Essential Oils containing Sulphur.—There are several essential oils which contain nitrogen and sulphur, amongst which the oil of black mustard-seed, garlic, assafœtida, and horseradish, are the most remarkable; they are fetid, and blacken silver.

Essoign (Fr. ensoigne, essoin). In Law, an excuse for one who is summoned to appear and answer an action or perform suit in a court, &c., by reason of sickness or other prevailing cause. The first return day in every term was called the *essoign* day, because the court sat to it to take essoigns; i.e. excuses for such as did not appear according to the summons of the writ. The essoign day seems to be done away with by the effect of the statutes 11 Geo. IV., 1 Wm. IV. c. 70, 1 Wm. IV. c. 3.

Essonite. A mineralogical synonym of the *Cinnamon Stone* of Ceylon: it is a silicate of lime, alumina, and oxide of iron.

Essorant (Fr. essor, the *soaring* of birds). In Heraldry, a term for a bird standing with its wings expanded, as if drying itself.

Establishment. [Foundation.]

Establishment of the Port. A term used by writers on the tides, to denote the interval between the time of high water at any given port and the time of the moon's transit immediately preceding the time of high water, when the moon is in syzygy; that is, at the new or full moon. This interval is influenced by local circumstances, and consequently different at different places. [Tides.]

Estafette (Fr.; Span. estafeta). Applied originally to military couriers, but now used in all the countries of modern Europe to signify an *express*. The difference between a courier and an estafette consists in this, that while the courier must deliver the despatches, &c. intrusted to him personally at the place to which they are addressed, in the estafette the despatches, letters, &c. to be forwarded are consigned to the care of postilions, who are

changed with every relay of horses successively till they arrive at the place of their destination.

Estate. In common parlance, is applied to the landed property held by individuals; and a man is said to be of good or of small estate, according to the magnitude of his landed property.

The comparative magnitude of estates, in other words, the number of persons possessing land in different countries, and the method by which the occupancy of land is characterised, are questions of great interest in connection with what economists call the distribution of wealth. This interest is contained not only in the general fact, that in a given population the existence of great wealth in some hands implies great poverty as the lot of others, particularly where the industry of a country is turned especially towards agricultural pursuits; but because by a natural process political influence is invariably connected with the tenure of land, and possessed in a measure by those who hold land disproportionate to the numerical value of the real estate and its profits. The landowners of a country are ultimately its rulers; and a community is invariably led into that political constitution which is most congenial with the habits and interests of the owners of its soil.

Of the number of landowners in England we are quite ignorant; no registration of land, except in two counties, Middlesex and York, having been customary in this country. For a short period, that is during the time in which the Statute of Enrollments was operative, such a registration was in course of creation; but the devices of lawyers, and the desire of secret conveyance on the part of landowners, rendered the statute nugatory almost from its commencement. We may be certain, however, that the number is decreasing, as the power which the practice of primogeniture and the privilege of strict settlement give, of creating what is virtually a perpetual entail, tends to agglutinate properties into vast estates, by precluding the possibility of division, as well as by giving facilities for acquisition. According to the latest returns, the annual income of real estate in England and Wales is upwards of one hundred and twenty millions; in Scotland and Ireland it is nearly thirty millions.

In France it has been calculated that the cultivated soil is divided among about six millions of proprietors, five millions of whom possess estates of no more than an average of three hectares, or seven and a half acres. The question, however, whether the number of occupiers increases or diminishes in France, is still open and debated. The reader will find sufficient information on the subject in the useful annual of Mr. Frederic Martin, *The Statesman's Year Book.*

Estate. In Law, the legal *quantity* of the right of property in the individual.

Estate of Inheritance. In Law, an estate in FEE SIMPLE or FEE TAIL. [See those articles.]

Estate for Life. In Law, a freehold interest in lands and tenements, whether enjoyed for the life of the tenant, or for the life of another party (in which latter case it is termed an estate *pur auter vie*). This species of interest includes estates granted for an uncertain period limited within the duration of a life; as, for instance, an estate granted to a widow during her widowhood. An estate for life is created wherever lands or tenements are given by means adequate to the conveyance of a freehold, without any express limitation of an estate. If tenant for life convey an estate greater than his own by feoffment, fine, or recovery, he forfeits his estate; but if he does so by any of those conveyances which are termed *innocent*, he creates an estate determinable on his own death. With respect to estates pur auter vie, it is observable that, formerly, when lands were given to A for the life of B, if A or A's assignee happened to die in B's lifetime, the estate belonged to the first person who could take possession, termed an *occupant*; but if given to A *and his heirs* for the life of B on the same event, A's heir succeeded as special occupant. Now by the Statute of Frauds (29 Ch. II. c. 31 s. 12), estates pur auter vie are devisable; and, if there be no special occupant, they go to the executors or administrator of the deceased.

Estate for Years. In Law, an estate limited for a term of years, or other determinate time, in lands, tenements or hereditaments, is a chattel or personal interest; and on the death of the owner, devolves, like other personal property, on his executors or administrator. An estate for years is properly created or *demised* by an instrument termed a *lease*; which, at common law, has not full operation until the entry of the tenant. It may also be created by declaration of use, or by devise in a will; and may be made either to commence immediately, or on a future day and event: in which latter case, unless there be any particular estate to support it as a remainder, it is called an *interesse termini*, until the time arrives for its reduction into possession. Covenants between the lessor and lessee relating to the land (which are usually inserted in the lease) are said at common law to run with the land: they pass, along with the term of years, to a party to whom the lessee conveys it by assignment; but the lessee's covenants do not pass to a party to whom he conveys part of the term by underlease. A tenancy from year to year is a species of estate for years.

Estates, Political. [STATES.]

Estivation. [ÆSTIVATION.]

Estoppel (Old Fr. estouper, *to stop*). In Law, an impediment or bar to a right of action, arising from a man's own act, or that of one to whom the party estopped is privy. As, if a party is bound by a particular name in an obligation, and afterwards sued by that name on the same obligation, he is estopped, i. e. forbidden in law to say in abatement that he is misnamed; as he cannot say contrary to that

which he has admitted by his own deed. All parties to a deed are estopped to say anything against what is contained in it; and privies are also bound.

Estrade (Ital. estrada). The portion of the floor of a room raised two or three steps above the general level, for the purpose of receiving a bed or throne; it is used now for any portion of a raised floor.

Estreat (Lat. extractum, *a thing taken out*). In Law, the extract copy, or note of some original writing or record, and especially of fines and amercements, entered on the rolls of the court, to be levied by its bailiff or other officer. Fines to the king are estreated into the Court of Exchequer. Estreats are made out in that court by the remembrancer for the lord treasurer, and received from him by the clerk of the estreats, who writes them out to be served for the king, &c. Provision is made for the due return, estreating, and levying of fines, &c. in the superior and some other courts by 3 & 4 Wm. IV. c. 99.

Estrich. The commercial name of the fine down of the ostrich.

Estuary. [ÆSTUARY.]

Et Cætera (Lat.). In Printing, usually expressed by the sign *&c.*, means *and so on.* It was formerly properly printed *&c.*, an obvious form of *etc.*

Etærio (Gr. ἑταῖρος, *a companion*). In Botany, an aggregate fruit, having the ovaries distinct, and the pericarp indehiscent. It is either dry upon a fleshy receptacle, as the Strawberry; or dry upon a dry receptacle, as the Ranunculus; or fleshy upon a dry receptacle, as the Blackberry: the parts being achenes or small drupes.

Etat, Coup d'. This French phrase denotes a sudden political move or stroke in order to subvert an existing state of things without the risk of a prolonged contest. The present emperor of the French resorted to such a measure, when, on December 2, 1852, under the pretext of 'saving society,' and contrary to the terms of the oath taken by him before entering on his office, he virtually suppressed the constitution of the Republic, of which he was the president. It is significant that the English language furnishes no phrase for such measures.

Etching. [ENGRAVING.]

Etching Needle. An instrument of steel, with a fine point, for tracing outlines &c. upon the copper plate.

Etesian Winds. [WINDS.]

Ethal. A substance formed during the saponification of spermaceti. Chevreul coined the name from the first syllables of *ether* and *alcohol*, on account of its analogy to those liquids in point of composition.

Ether (Gr. αἰθήρ). In Chemistry, this term is applied to a highly volatile, fragrant, inflammable, and intoxicating liquid, produced by distilling a mixture of equal weights of sulphuric acid and alcohol. When these liquids mutually act on each other, a series of complicated changes ensue, which terminate in the conversion of the alcohol into ether. Ether, like alcohol, may be regarded as a compound of hydrocarbon and water; and if alcohol be considered as consisting of *one* equivalent of olefiant hydrocarbon = 14, and *one* of water = 9, ether may be regarded as constituted of *two* of olefiant hydrocarbon (14 × 2) = 28, and *one* of water = 9: hence, the equivalent of alcohol being 14 + 9 = 23, that of ether will be 14 × 2 = 28 + 9 = 37; and the process of etherification may be stated to consist in the abstraction from alcohol of one-half of its elemental water. By some, ether is regarded as the oxide of a peculiar hydrocarbon, which they term *ethyl*, composed of 4 equivalents of carbon and 5 equivalents of hydrogen; and alcohol must in that case be considered as hydrate of ether.

Ether, or, as it is often called, to distinguish it from analogous products obtained by the intervention of other acids, *sulphuric ether*, is a limpid colourless fluid, of an agreeable odour, and a hot pungent taste. Its specific gravity is about 0·713, though that of the shops is usually heavier; it boils at about 98°, and freezes at the low temperature of 46° below 0°. The specific gravity of etherial vapour compared with atmospheric air is as 258 to 100. Ether is sparingly soluble in water, which takes up about a tenth of its bulk; it dissolves in all proportions in alcohol. The principal use of ether is in medicine. When taken internally, it is stimulant; and it is sometimes applied externally, in consequence of the cold produced during its evaporation, as an ingredient in refrigerating lotions. Ether was at one time much used as an anæsthetic, but in this respect it is superseded by chloroform.

Ethereal Salts. Combinations analogous to metallic salts, the metal being replaced by a compound organic radical, such as ethyl. They are generally colourless, volatile, and have a peculiar and powerful odour. Many of them resemble, and are probably identical with, the odoriferous and flavouring principles of edible fruits.

Etheria (Gr. αἰθέριος). A genus of Lamellibranchiate Dimyary Bivalves, with a large ventral muscular plate or foot, as in the *Unio*s, but having their shell adherent, as in the oyster, to foreign bodies: the hinge is toothless, irregular, undulated, and callous; the ligament external, but penetrating in a pointed form into the interior of the shell. The term *Etheria* has also been applied by Rafinesque to a genus of Macrourous Crustacea.

Etherin. A name applied by some chemists to quadrihydrocarbon; that is, to an hydrocarbon, 1 atom or equivalent of which is constituted of 4 atoms of carbon and 4 of hydrogen.

Etherine or **Etherol.** *Light oil of wine.* A volatile oily hydrocarbon formed during the preparation of ether.

Ethers. Oxides of organic positive radicals of which common ether (*oxide of ethyl*) is the type. They are generally volatile liquids; one,

however, is gaseous (methylic ether), and a few are solids. Ethers are generally neutral to test paper, but act as bases to acids, the resulting compounds being ETHEREAL SALTS. *Haloid ethers* are combinations of non-metallic elements, other than oxygen, with positive organic radicals.

Ethics (Gr. ἠθικός, from ἦθος, *moral temper*). The science which treats of the laws of voluntary action, and thus seeks to determine the nature and extent of moral duty. The several systems of ethical philosophy are conveniently divided into ancient and modern. The distinction, however, is not founded on any essential difference of theory, but rather on the opposite points of view from which they respectively viewed the subject-matter of the science. While modern theories are permanently subjective, the objective question is the characteristic feature of ancient ethics. The leading speculation of the former is: What is the origin and nature of moral obligation? The first problem of the latter was to determine the object or end to which the moral constitution of man has reference, and this ultimate end of human activity they usually denominated the end or sovereign good (τέλος, *finis bonorum, summum bonum*). And although the consideration of this question might tend in a few, as in Socrates and Plato, to carry the mind forward to some higher and ulterior existence, in which should be realised that entire satisfaction after which man aspires, still, as these promptings of natural religion were but vague and unauthoritative, the ethical writers of antiquity confined their views to this life alone, and the sovereign good which they proposed as the final cause of moral action was limited to the greatest good attainable in the present state of existence.

With Socrates, the first object of speculation was to acquire a knowledge of man's true and proper nature; but this self-knowledge he held to be impossible so long as man continues ignorant of the universal principle. Now the nature of God can only be learnt from His works, and these bespeak Him to be good and intelligent. Moreover, the consciousness of man attests his participation in the divine essence; consequently the ultimate destination of man is reason and goodness, and his moral end is the cognition and practice of good. Virtue, therefore, is the intelligent performance of duties, a knowledge of which man may arrive at by a study both of his own nature and of the laws of an all-wise Creator discoverable in the system of the universe. In this pursuit happiness is inseparable from virtue. But if Socrates thus founded morality on a disinterested principle, he reconciled it with interest rightly understood; and on the other hand raised political science above the mere calculation of utility, by identifying it with justice as founded not on convention (δόγμα πόλεως), but on natural right, or the invention of what is (τοῦ ὄντος ἐξεύρεσις).

Thus the ethics of Socrates, in their close connection with political science, had the same foundation of fact with the Baconian philosophy. It was in his belief a strictly inductive, and not a deductive science; and, to understand his system aright, it is essential to remember that on this ground alone he insisted on the superiority of moral over physical science. Nor could it well have been otherwise, if we consider the slender amount of experimental knowledge which had been attained in his day. In the field of the natural sciences, Socrates saw nothing but a Babel of conflicting speculations. While Heracleitus taught that the light of the stars was fed by exhalations from the earth, Zenophanes held that they were fiery clouds, lit at night and put out in the morning. According to Parmenides the earth was spherical, and placed at the centre of the universe; while Anaxagoras held that it was a plane, and Anaximenes believed that its form of a flat trapezium prevented it from sinking in space. Astronomy, therefore, 'now exhibiting the maximum of perfection, with the largest and most exact power of predicting future phenomena which human science has ever attained, was pronounced by him to be among the divine mysteries which it was impossible to understand and madness to investigate.' (Grote, *History of Greece*, viii. 5, 77.) Thus, turning away from sciences which started with a theory and reasoned in support of it, Socrates confined himself to that field of human practice which he felt that men were competent to examine, while the very fact that men could examine it to some purpose proved convincingly that 'the proper study for mankind is man.'

Socrates having thus referred the laws of morality to the Deity as their author and upholder, Plato proceeded by a definition of the divine nature to guard against the objection of their arbitrary position by the will of God. He made the Deity to be the perfection of intelligence as resulting from a union of the good, the beautiful, and the true, which are in their nature eternal, necessary, and immutable. This perfection is also the term to which man spontaneously tends. For reason is the true principle of his nature, although in the present existence there is mingled with it a foreign element—*matter*, which, by obstructing its developement, becomes the cause of his falling short of perfection. All, then, that is now possible for man is an approach to the divine excellence. This is virtue, and is effected by the harmony of the *rational*, *irascible*, and *concupiscible* parts of the soul. Although the two latter belong to the foreign element in man's nature, they are yet indispensable to the moral act: for the third affords a motive to action, inasmuch as beauty, being identical with the good and true, gives rise to desire or love (ἔρως), and thereby impels to virtuous action; while the second, disapproving what is base, unseemly, and false, furnishes the fortitude requisite for attaining to what is approved under every difficulty and every discouragement. To each of the three parts of the

soul Plato assigns a special virtue, in a lower sense, and names them, respectively, *prudence*, *fortitude*, and *temperance* (φρόνησις, ἀνδρία, σωφροσύνη), while in a proper sense he declares virtue to be eminently one and the same with justice (δικαιοσύνη). These four are the so-called cardinal virtues. From the notion of justice he draws the connection of ethics and politics: the latter is but an application of the former to society. At the close of the *Republic* he teaches that as an individual cannot be at peace with himself except by the harmonious adjustment of all his faculties, wherein each is allowed its due weight, so in the whole world happiness is proportionate to justice, and each individual derives the greater benefit from the community the more complete the harmony is in which he lives with all his fellow-citizens.

Essentially agreeing, the ethical systems of Plato and Aristotle are chiefly distinguished by the relative value which they respectively ascribe to happiness; the former considering it as the natural fruit of virtue, while the latter rather viewed virtue as the means of attaining to happiness. Plato taught, that although the just man regulates his conduct by no reference to his own enjoyment, yet pleasure invariably attends him, since justice is good not only in itself, but also in its effects, and renders all things fitting and friendly to man. In Aristotle's opinion, the end of morality is to render individuals as useful as possible to society, society being instituted in order to procure in its members the highest moral perfection, as necessary to the attainment of the greatest possible felicity by the whole. Man, he teaches, is a free and rational agent, and therefore acts spontaneously and deliberately, invariably proposing to himself some end as the motive to action. All human arts and pursuits, then, have their appropriate ends; but among these there is a certain subordination, which implies a supreme end towards which they all converge, this end being the cause for which all else is sought. This supreme good is happiness (εὐδαιμονία): virtue is the approximation thereto, and consists in the habit of mediocrity according to right reason; in other words, it is self-control, which triumphs alike over the impetuosity of the passions and the weakness of the will, and thereby accomplishes a just mean. Every special virtue, in like manner, lies in a kind of middle between the two opposite vices of excess and defect: courage, for instance, being a mean between cowardice and rashness, of which the former offends by an excessive, the latter by a defective, regard to the proper objects of fear.

According to the Stoics, the supreme good which is the final cause of every special good is to act conformably to nature; i. e. in obedience to the immutable laws which reason discovers in the universe. This eternal and universal order, which they called *fate*, is an infinite enchainment of causes and effects, in virtue of which whatever happens is what ought to be: it embraces all living things, and man therefore has a principle within him which obliges him to seek that state of his nature which is the best and most perfect that it is capable of. This is reason. Wisdom, therefore, is man's chief good, and the pursuit of it is philosophy. Perfect wisdom, however, as modelled in the ideal sage of the Stoics, they did not believe to be conceded to mortals, to whom nothing more is granted than to be in *the way to* perfection. Now, as they made reason to be the supreme arbiter in moral determinations, they naturally held vice to be but an error: yet this error, they taught, is the only evil; and, on the other hand, nothing is good but what is such in all times and all circumstances: all else is morally indifferent. But even indifferent things are, in a lower sense, agreeable to nature, and objects more or less of choice or aversion. That perfect rectitude of conduct, therefore, which constitutes the essence of virtue, consists in a just and accurate discernment of good, and in assigning to every object its due importance according to the place it holds in the natural scale of things. Lastly, although their first object was to emancipate the moral man from all dependence on external conditions and from the slavery of his passions—and although, therefore, they removed all sensuous pleasures and pains from the catalogue of good and evil—nevertheless, the apathy which they taught was not, as commonly understood, an absolute insensibility, but rather the undisturbed supremacy of reason over the passions.

All the preceding theories agree in making reason the end of human activity, and are thereby distinguished from the Epicurean, which gave the first place to the sensuous element of humanity, and reduced science to the rank of a mean. According to Epicurus, pleasure alone is sought for its own sake, and philosophy and all else is but the pursuit of it. If, sometimes, it seems to be foregone, it is only with a view to some higher gratification, as pain also may occasionally be endured in the acquisition of a pleasure whose intensity will fully compensate for the intermediate suffering. The pleasures and pains that are primarily the objects of desire and aversion are corporeal, and from these the pleasures of the mind are ultimately derived, and consist merely in the anticipation of future and in the recollection of past states. This, however, constitutes the superiority of the secondary pleasures of the mind over their corporeal originals, for the latter do not extend beyond the present sensation. *Virtue*, therefore, is an enlightened pursuit of pleasure, which, although it is selfish in its principle, still allows free course to the social and benevolent affections, as being a part of man's nature and an additional source of gratification beyond the calculations of personal interest. For though they may expose a man to the chance of pain, as in the case of the death of a friend, still this is a less evil than apathy, and the deprivation

of a natural enjoyment. Justice, lastly, has no other object than the general good; and right, properly understood, is but the sign of utility.

Modern ethics having taken their rise from a system greatly resembling the Epicurean, the enquiry into the nature of virtue became the first question that was proposed for solution. Accordingly this fact furnishes a general classification of the later theories of morals into selfish or disinterested, according as they found virtue on a selfish or on a benevolent principle.

The selfish theory has found its ablest advocates in Hobbes, Helvetius, Paley, and Bentham. Of these the first and last deserve a particular notice: Hobbes as the originator of the controversy into the nature of morality; Bentham as furnishing the most complete and elaborate exposition of the utilitarian scheme. According to Hobbes (born 1588, died 1679), the only motive that can induce men to any act is the pleasure which will follow from its execution. A preconception of pleasure is the necessary condition of every moral determination. Good and evil are simple tendencies to pleasure and pain, without which every object is indifferent. Self-love is the exclusive passion of man's nature. Other passions differ from it outwardly only, i.e. in the objects which excite them: pity, for example, is but the imagination of misfortunes which may happen to ourselves, suggested by the contemplation of another's sufferings; love, the conception of advantages to be derived from its object; and benevolence, nothing more than the consciousness of power sufficient to secure not only one's own happiness, but that of others also. The first law of nature is self-preservation: whatever tends, therefore, to this end is lawful and good, and all men have a natural right to appropriate by every means in their power whatever may contribute to their personal happiness. As this is the imprescriptible right of all, there are as many forms of natural right as there are separate and independent wills; and actions of the most opposite kinds are equally virtuous and legitimate. Now, as all possess an equal right to all things, and as there is no reason why one should yield to another the objects which both may desire, the state of nature must be one of war; but as, in such a condition of things, the safety of everyone is constantly endangered by the conflicting interests of all others, peace, at any price, becomes preferable to it. Peace, however, is the result of society alone; i.e. as defined by Hobbes, of the existence within a community of a sufficient force to control all individual wills and forces. But this is only practicable in two ways: either all are seized with a desire to terminate the state of hostility, and enter into a mutual compact, by which they engage to do no violence, nor to suffer it to be done to each other; or a single person succeeds by stratagem or force in establishing his own authority over the rest. The latter form of society is as legitimate as the former; and indeed, as the end of the institution is the suppression of warfare among its members, and as the more unlimited the power is the better calculated it must be to effect this object, an absolute monarchy is the very best polity that can be devised. Against the government in such a society, it is evident that subjects cannot consistently possess any rights; for these would impede its effectiveness: they have but one simple duty, and that is—implicit obedience. (*On Human Nature; Leviathan, &c.*)

Bentham (born 1748, died 1832) sets out from Hobbes' principle, that every object would be perfectly indifferent but for its fitness to produce pleasure or pain, which, he declares, are the sole motives of human determinations. This proposition he does not attempt to prove, but, asserting that it is one of those primary and self-evident truths which are the foundation of all reasoning, he proceeds to draw from it certain practical conclusions in the form of definitions. Thus he defines utility to be the fitness of actions and things to augment the happiness, or to diminish the misery, of individuals and communities; and maintains that this is the only true and intelligible interpretation of what is usually called the lawfulness, goodness, justice, and morality of an action. The principle of utility is next defined to be that which exclusively derives the quality of actions from their twofold property of augmenting the happiness or misery of one or many. This, he asserts, is the only valid principle of moral appreciation; and he reduces all opposing theories to two classes, which he designates by the principle of asceticism, and the principle of sympathy and antipathy. Under the latter head, Bentham comprises every theory of morals which draws the distinction of good and evil from any other principle than a consideration of consequences; whereas he explains the ascetical principle as agreeing with the utilitarian in drawing its qualification of objects from their tendency to produce pleasure or pain, but as differing from it in that it proceeds in an inverse manner, and calls pain good, but pleasure an evil. To forego the least pleasure, simply as pleasure, is to act on a principle of asceticism; but the true disciple of utility holds every pleasure to be in itself good. Even the abominable pleasure which the criminal enjoys in gloating over his crime is good, so far as it is a pleasure; it is only evil so far forth as it entails the ill consequences of fear and punishment, which far transcend its guilty enjoyment. The practical conclusion, therefore, of the theory of utility is, that an action is only really good when it will give rise to more of pleasure than of pain; and evil, when its painful consequences exceed its pleasurable results. It becomes, therefore, of the first importance to possess an accurate standard by which the amount of pleasure and pain likely to result from certain actions, and the relative value of the two quantities, may be measured. This desideratum Bentham has attempted to supply in a manner that constitutes the most original and characteristic feature of his theory

and system. The first item of this moral arithmetic is what is intended for an exhaustive enumeration of all the pleasures and pains of which human nature is susceptible: in the next, he proceeds to furnish a method of determining their comparative value. For this purpose it is necessary to take into the account the following considerations: I. What are the intrinsic circumstances of the pleasure itself which can augment or diminish its value: and these are, 1. intensity; 2. duration; 3. certainty; 4. proximity, or remoteness; 5. fecundity, or the probability of its immediate pleasures engendering others more remote; 6. purity, or whether its pleasures are mixed or not with more or less of pain. II. What circumstances are likely to affect the sensibility of the agents, and so to modify indirectly the result. These are of two kinds, individual and general: to the former belong temperament, constitution, habits, intellectual developement, and other traits of personal character: those of the latter order are little more than generalisations of the first, and are—sex, age, education, profession, climate, national character, government, and religion. III. What are the consequences which, going beyond the immediate objects of the action, remotely affect others more or less numerous, and even the whole of society. By allowing their due weight to all these particulars, Bentham pretends that any ordinary capacity may form a correct estimate of the real tendency of actions, and thereby arrive at that general utility which it is the proper end of morality to secure. (*Treatise on Morals and Legislation.*)

The recognition of a principle of action independent of self-love will afford a general characteristic of the remaining theories. Some of these, however, place the origin of the disinterested determination in a perception of moral good and evil by the intellect or reason; while others explain the distinction by certain facts which take place within the sensibility or emotive part of man, so that the disinterested determinations which result proceed from an instinct or sentiment. These two classes may be conveniently designated the *rational* and the *sentimental* or *instinctive*. Of instinctive theories, however, while some are content with referring the moral principle to an original and admitted tendency of human nature, such as sympathy or benevolence, others have derived it from a new and peculiar faculty.

To begin with the former class. According to Adam Smith (born 1723, died 1790), when we are in the company of another who is sensibly affected with any sentiment or passion, our nature spontaneously, and without the intervention of reason or will, tends to reproduce in ourselves the same sentiment or passion: and not only have we this disposition to sympathy, but we even feel a pleasure in finding ourselves brought thereby into harmony with those around us. Indeed, so strong and so instinctive is the desire for such union between our own minds and those of others, that when we are under any strong emotions in the presence of another who is unable to conceive anything that approaches to the same degree of violence with our own, in such a case we involuntarily and unconsciously lower our passion to that pitch in which the spectator can go along with it. The spectator, on the other hand, seeing what we suffer, endeavours to enter into our sentiments, and rises by an instinctive complaisance to the level of them. In regard to those objects which have no peculiar relation either to ourselves or others, this sympathy is simple. In whatever degree, for instance, the love of truth may be felt, it will not directly affect the happiness of anyone; it cannot excite any feeling but a simple emotion of sympathy. It may, therefore, be allowed to appear as it is felt, because there is no reason either of instinct or of reason to suppress it. There are, however, certain internal dispositions which excite a twofold or even a triple sympathy, which are all of the same kind; thus, when we see a man animated with sentiments of charity and love, pity and benevolence, towards his fellow-men, we are affected by a twofold sympathy, *directly* with the benevolent disposition, and *indirectly* with the gratitude which is due from its objects. As, then, the two mutually strengthen each other, the benevolent dispositions evidently awaken the highest degrees of sympathy, and consequently they contribute most of all to effect that perfect harmony of sentiments and affections to which all men instinctively aspire. But, on the other hand, there is a divided sympathy. Suppose the case of merited anger; on the one hand we sympathise with the passion of anger, and on the other with the object of it, and with the sufferings which it may bring upon him. These are the elements of moral approbation and disapprobation. We approve those sentiments of others in which we ourselves are able to participate; and when this sympathy is pure our approbation is unqualified, but mixed with disapprobation when our sympathy is divided. But further, when we witness, for instance, an act of benevolence, we sympathise not only with the feelings of the actor, but also with the emotion of the party benefited. Now this emotion is gratitude; but what else is gratitude but an instinctive desire to do good to the benefactor? Consequently, as we participate in the feelings of the obliged party, we wish to do good to the author of the obligation; we feel that he *merits* it in reward for the good which he has done. As to the judgment which we pass on our own sentiments and actions, Adam Smith asserts that if it were possible for a human creature to grow up to manhood in some solitary place without communication with his species, he could no more think of his own character, of the propriety or demerit of his own actions, of the beauty or deformity of his own mind, than of the beauty or deformity of his own face. Since society is essential to sympathy, which is the rule of qualification of all our acts, the solitary cannot arrive at a consciousness of that

rule, and by it appreciate the morality or immorality of his acts. Our moral criticisms are first exercised upon the character and conduct of others, but we soon learn that others are exercising their judgment upon our own: we become anxious to know how far we deserve their censure and applause; and, in order to examine in this respect our own passions and conduct, we have the faculty of supposing ourselves spectators of our own dispositions and behaviour, and so experience in some degree the sensations which would be excited in our minds by the sight of similar actions and feelings in another. By virtue of this faculty we feel as it were a sympathy with ourselves when we have acted well, and are led to suppose that all other spectators will be similarly affected. This consciousness of unison between our own conduct and the sentiments of our fellows constitutes the pleasure of rectitude. And further, by aid of the same principle by which we judge of the actions of others, we feel that we have a right to pronounce our own also to be good. This is a source of inward tranquillity and satisfaction, while the least suspicion of the contrary gives rise to the pains of remorse. In manhood, indeed, when experience has drawn a system of general rules from the occasional judgments of sympathy, and established them in the mind, a new source of pleasure arises. We have now an intellectual perception also of the conformity of the act with the law of morality; and independently of the instinctive approbation, the reason also awards to it its sanction. This rational perception is wanting in the infantine and uncultivated mind; but it is invariably found wherever education or experience has stored the mind with the general maxims of morality which are primarily founded on the instinctive emotions. The act of reason in approbation is simply a perception of the agreeableness of the act with the moral laws, and therefore implies them. Lastly, the act itself appears by its very nature to be part of a system of conduct fitted to establish a perfect agreement of sentiments among mankind; and this universal harmony being eminently beautiful in itself, we judge, in virtue of this perception, the act in question to be not only good but even beautiful. This is the principle of moral beauty, which is the origin of every other species of the beautiful. (*Theory of Moral Sentiments.*)

The doctrine of a moral sense owes its origin to Lord Shaftesbury (born 1671, died 1713). According to this writer, the human dispositions are of two kinds—the social or benevolent, and the personal or selfish. The former lead us to desire the welfare of others simply for its own sake and without regard to our own interests. In the developements of these affections the soul takes part, and some are naturally agreeable and others disagreeable to it; of the former it approves, while it disapproves the latter. As, then, these dispositions are a source of pleasure to the soul, there must be in it some faculty distinct from the dispositions themselves, by virtue of which they become agreeable or otherwise, and which performs the same office in their case as they do with respect to their immediate objects. This faculty Shaftesbury calls a sense which he characterises from its mode of operation as *reflex*, and from its object-matter as *moral*. The dispositions which this reflex sense approves or disapproves are morally good or evil: virtue consists in yielding to the former, but resisting the latter. Between goodness and virtue there is agreement, but not identity; the former being merely a constitutional predominance of the benevolent affections in the character and conduct, the latter being the same state produced by the operation of the conscience or moral sense, which, when the personal affections are of equal force with the social ones, interposes its authority, and inclines the balance in favour of the latter.

Butler (born 1692, died 1752) in the same manner divides the principles of action into those which lead directly to private good, and those which promote immediately the good of the community. 'There are,' he says, 'as real and the same kind of indications in human nature, that we were made for society and to do good to our fellow-creatures, as that we were intended to take care of our own life and health and private good, and that the same objections lie against one of these assertions as against the other.' At the same time, he shows that the several passions and affections, which are distinct both from benevolence and self-love, do in general contribute and lead us to public good as really as to private. The promotion of the latter is the proper end of self-love; but self-love is by Butler carefully distinguished from selfishness, which consists in the weakness of the public affections and the undue strength of personal desires. Self-love, or an enlightened regard to our general happiness and highest ultimate interest, is not a vice, and is generally not nearly as strong in men as it ought to be; but selfishness is utterly at variance with the happiness of him who harbours it, since without the gratification of the benevolent feelings it is impossible to attain to the greatest satisfaction of our nature, of which they are a part. But, besides these personal and social instincts and self-love, Butler discovers in man another faculty, which by its very nature is supreme over all others, and authoritatively approves or disapproves both the affections of our minds and the actions of our lives. This principle is conscience. Its perceptions are immediate, and its very idea implies that supremacy and authority are essential to it. The nature of man is thus a complex constitution, and we cannot determine the final cause of his being unless we have a due knowledge of the component parts in their relation among themselves and to the end which they are designed to serve. 'Every work,' he argues, 'both of nature and art, is a system; and as every par-

ticular thing, both natural and artificial, is for some use or purpose out of and beyond itself, one may add, to what has been already brought into the idea of a system, its conduciveness to this one or more ends. Let us instance a watch: Suppose the several parts of it taken to pieces, and placed apart from each other; let a man have ever so exact a notion of these several parts, unless he considers the respects and relations which they have to each other, he will not have anything like the idea of a watch. Suppose these several parts brought together and united anyhow: neither will he yet, be the union ever so close, have an idea which will bear any resemblance to that of a watch. But let him view those several parts put together, or consider them as to be put together in the manner of a watch; let him form a notion of the relations which those several parts have to each other—all conducive in their respective ways to this purpose, showing the hour of the day; and then he has the *idea* of a watch. Thus it is with regard to the inward frame of man. Appetites, passions, affections, and the principle of reflection, considered merely as the several parts of our inward nature, *do not at all give us the idea of the system or constitution of this nature; because the constitution is formed by somewhat not yet taken into consideration, namely, by the relations which these several parts have to each other*.' Bishop Butler goes on to remark, that 'what in fact or event commonly happens is nothing to this question;' for, 'one may determine what course of action the economy of man's nature requires, without so much as knowing in what degrees of *strength* the several principles prevail, or which of them have actually the greatest influence.' But between a machine and a man, he remarks, in reference to the illustration from the watch, 'there is a difference too important ever to be omitted. A machine is inanimate and passive; but we are agents. Our constitution is put in our own power. We are charged with it; and therefore are accountable for any disorder or violation of it.'

The first object of Hutcheson (born 1694, died 1747) is to show that the very frame of our nature which determines us to pursue happiness for ourselves, also determines us both to esteem and to benevolence on their proper occasions. Besides these original desires, he shows that there arise, in consequence of them, *secondary* desires of everything useful to gratify the primary ones. But there is also in man an idea of moral good which can be explained by neither of the former. By a careful analysis, Hutcheson shows that by moral good we understand neither what gives pleasure by satisfying our benevolence, nor what is simply good to others; nor is it what is useful to others or agreeable to the spectators; nor, lastly, is it a conformity to the will of God, or to law, or truth, or order: it is simply what the word itself expresses, which is simple and original and inexplicable by any other. From this originality and simplicity of the term, Hutcheson argues that it must be perceived by a sense, because the senses alone are percipient of simple qualities; and by a special sense, since the quality apprehended by it differs from all other objects of sensation. Further, he observes that this perception is attended with pleasure, which is the property of all sensuous perceptions; and that as moral good is an end and motive of action, it must be apprehended by a sense, since the understanding can neither propose the ends of human activity nor exercise any influence on the will. Again, the pleasure which accompanies the perception of good, being a consequence of the discovered quality, necessarily presupposes it; therefore it is impossible to resolve moral good, or the approbation which we award to it, into that pleasure; this would be to resolve the cause into the effect, and the consequence into the principle. As the qualities which it is the province of the moral sense to discover belong to the internal affections and emotions, it is internal, and not external, although, like the outward senses, it is capable of improvement by education and habit. This sense is designed to govern all the others, and we have an immediate consciousness of its authority. Reason is the servant of this sense, its only office being to discover and to combine the means necessary to the attainment of the objects which the moral sense approves of. The object of this approbation is benevolence alone: every action, therefore, which has in view our own advantage may be innocent, but cannot be virtuous. (*Inquiry into Beauty and Virtue*.)

According to Hume (born 1711, died 1776), all the mental qualities and actions which are generally approved of by mankind agree in the circumstance of being useful to society. The fact that the different degrees of moral approbation correspond to the degrees of utility, affords an explanation of the greater merit ascribed to the benevolent passions: for these tend to the happiness of many, and indeed of all; whereas the personal affections tend to that of the agent alone. Yet even the latter are in a degree meritorious, inasmuch as they are useful to one, and they are only to be blamed when they are entertained at the sacrifice of the social feelings. The pursuit of self-interest is in the latter case culpable, although in itself it is not only innocent, but praiseworthy: for we admire in any character certain qualities, such as prudence, for instance, merely because they appear fitted to promote a man's personal welfare. In short, whatever is useful is morally good, and is only to be disapproved when it is preferred to what is more useful. That which judges of utility and the contrary is reason; but if we approve of one and disapprove of the other, and call the former good, but the latter evil, this is in virtue of a primary sentiment of our nature, which leads us to prefer the useful to the hurtful, as we prefer what is sweet to what is bitter. This instinct, however, is distinct from and frequently opposed to self-love; for this

would lead us to love what is useful to ourselves, and not what is useful in itself absolutely and independently of any reference to our own advantage. This instinct is commonly called *conscience*, or the moral faculty, but more frequently designated by Hume as *benevolence* or *humanity*, inasmuch as its object is the good of mankind generally. As to the idea of moral obligation, it is simply a conception of the understanding. What is honoured by this name is, he says, nothing more than the undoubtedly correct view, that there is more happiness in obeying the impulses of the moral sense than in following the dictates of self-love. The reason is incapable of exercising any influence on the will. What determines us when we resolve to act rightly is merely the charm which utility exercises on the mind, and the force of certain dispositions which propel us to seek the good of ourselves and others, and are invariably seconding the promptings of conscience. (*Inquiry concerning the Principles of Morals.*)

Mackintosh (born 1765, died 1832) agrees with all the writers of the distinctive school in denying conscience to be either a state or act of the understanding; but he differs from one form of the sentimental theory by denying that man has any special organisation for moral perception, while he equally dissents from the other view, which would refer these perceptions to some one of the original and admitted sentiments of our nature. Butler and Stewart had shown that self-love is a secondary principle; and Hartley had exhibited the important part which association plays in the formation of our passions and affections, and even of our sentiment of virtue and duty. This view was further developed by Mackintosh, who declared conscience itself to be a similar derivative. In the same manner he says that in the formation of self-love the desire which originally attaches to external objects is transferred to the pleasure which results from their attainment; so in the case of conscience the agreeable and disagreeable sensations which belong naturally to certain actions are transferred to the volitions which determine conduct, so that the latter become at last the immediate objects of love and repugnance. In this manner there is formed by association a number of secondary desires and aversions, whose proper object is volition, and which collectively form that interior principle called *conscience*, which judges, without regard to consequences, unerringly and authoritatively. As to the action of conscience on the will, this is composed both of the peculiar energy of the primary dispositions, which it causes to triumph, and of the pleasures naturally attached to them, as well as those which are produced by the gratification of the secondary affections. Accordingly, Mackintosh strongly insists upon the distinction between perception and emotion, and declares that the phrase *association* of ideas, as overlooking this distinction, conveys but a partial and incomplete view of the truth. He therefore proposes to substitute for it association of thoughts with emotions and with each other, but at the same time declares that the term *association* very inadequately indicates that perfect combination and fusion which occurs in these operations of the mind. For the moral faculty is properly and intelligibly spoken of as one. Now it is as common in mind as in matter for a compound to have properties not to be found in any of its constituent parts: the originally separate feelings are so completely blended together that they can no longer be disjoined from each other. Thus the sentiment of moral approbation, formed by association out of antecedent affections, may become so perfectly independent of them that we are no longer conscious of the process by which they were formed. It is in this mature and sound state of nature that our emotions at sight of right and wrong are ascribed to conscience. And although this supreme arbiter and judge of human conduct does not supersede the ordinary motives of virtuous feelings and habits, which are the ordinary motives to good actions, it yet exercises a lawful authority over them. Whatsoever actions and dispositions are approved by conscience acquire the names of virtues and duties; they are thereby pronounced to deserve commendation, and we are justly considered as under a moral *obligation* to practise the actions and cultivate the dispositions. The peculiar character of the moral sentiments is their exclusive reference to *states of the will*, and this is a character both of the private desires and social affections, and indeed, among the many dissimilar elements that enter into the formation of conscience, this is the only common property that the mind can discover. Hence, however, the facility with which general terms, at first limited to relations between ourselves and others, are gradually applied to any voluntary acts and dispositions: it is thus that prudence and temperance, for instance, become objects of moral approbation. On the other hand, as the will is the sole means of gratifying any passion, the power of conscience is coextensive with the whole man. It is a universal principle, because will is the universal means. And as, when the mind is in a healthy state, nothing is interposed between it and the will, the dictate of conscience is immediately followed by a determination of will; conscience is thus at once universal, independent, and commanding. Lastly, as Mackintosh held that utility, as tending to promote the greatest happiness of the species, is the criterion of morality, he naturally felt himself called upon to explain the fact, that, while the moral approbation involves no perception of a beneficent tendency, there is nevertheless a striking coincidence between that principle and the moral sentiments. He replies that it is true that conscience itself rarely contemplates so distant an object as the welfare of all sentient beings, but that all its elements are invariably tending to this end. The social affections promote happiness so far as their foresight and power extend; the rules of justice are conducive, if not necessary, to the

well-being of society; even the angry passions, so far as they are ministers of morality, are employed in removing hindrances to the welfare of ourselves and others; and if the private passions terminate in the happiness of the individual, this is yet a part of the general happiness. And although this beneficent tendency be not one of the natural objects of conscience, because our voluntary acts are not felt to affect it, yet little is left to reason to perform; which is, to discover merely the truth, that the acts of those who labour to promote separate portions of happiness must increase the amount of the whole. (*Dissertation on the Progress of Ethical Philosophy.*)

The distinctive characteristic of the rational theory of morality is, that it considers the idea of good to be an à priori conception of reason, in which the idea of obligation is necessarily and essentially implied. As to the nature of the idea itself, two opinions have been held. While some moralists of this school pronounce it to be simple and immediate, others resolve it into some higher notion of the intellect, from which it derives at once its explanation and authority.

The most distinguished representatives of the latter opinion are Clarke and Wollaston; while the former has found able advocates in Cudworth, Price and Stewart.

According to Clarke (born 1675, died 1729), the universe is an assemblage of objects held together by certain mutual relations which result from their respective natures; but as the nature or essence of things is immutable and real, and the essence is the principle of the relations, the latter must be equally real and immutable; and as they must have been always present to the Eternal Mind, they are also eternal. Now, as soon as reason conceives these relations as constituting the laws of individual things and the order of the universe, they immediately appear to command the respect of every free and rational agent. Hence the obligation on every creature capable of thought to act conformably to those relations; and every act agreeable to them is judged to be good, and evil if opposed to them. Now, moral good being the conformity to the relations of objects, these, while they constitute, serve also to explain, all duties. Thus, the true nature of God and man, and their reciprocal relations, being known, the duties of man towards God are at once discoverable. In the same way, the duties of man to his fellows similarly suggest themselves from a consideration of their relations as equally free and independent beings; and as the latter relation is one of equality, whereas that between God and man is one of inequality, the difference between the two classes of duties which those relations respectively engender is at once conceivable. In confirmation of this view of the moral principle, Clarke appeals to the historical fact of the gradual developement of moral ideas among mankind: for the knowledge of the nature of things, and their consequent relations, is neither natural nor immediate to the mind, but is gradually unfolded by observation and science, which are more or less complete according to the degrees of its culture. The evolution of moral science, although subsequent to that of nature, nevertheless, being once awakened, is promoted by its progress, and keeps pace with the advancement of civilisation. (*Being and Attributes of God; Evidence of Natural and Revealed Religion.*)

Wollaston (born 1659, died 1724) makes morality to be conformity to truth. In support of this view he asserts that actions, like words, are but signs, and that consequently every true proposition, i.e. one which expresses things as they are, may be contradicted by deeds as well as by words. To violate a compact, for instance, is simply to deny by that act that there is any such compact subsisting. He then asserts that no act, whether word or deed, of any free and rational agent to whom moral good and evil are imputable, which interferes with any true proposition, or denies anything to be as it is, can be right. For, 1. If a false proposition be wrong, the act which implies, or is founded on it, cannot be right. 2. Whatever interferes with a true proposition, which expresses the relation between the subject and attribute as it is in nature, must, therefore, interfere with nature, and is consequently unnatural, or wrong. 3. An act which contradicts a true proposition contradicts what is, and is therefore a revolt against God, the author of whatever is. 4. To deny things to be as they are, is a transgression of the great law of our nature—the law of reason. What is said of acts inconsistent with truth may be said of omissions to act, since by these, also, true propositions may be denied to be true. For instance, whoever having engaged to do some certain act, nevertheless voluntarily omits to do it, behaves himself as if there had been no such promise or engagement. Having thus established his theory, he proceeds, like Clarke, to show that it is agreeable to facts, and especially with that of the progressive developement of morality. For morality, being simply the truth expressed in action, implies the knowledge of truth; and consequently the improvement of the moral perceptions must be proportional to the progress of science. It also affords an explanation of erroneous views in morality, and of the difference so universally drawn by the common sense of mankind between error and vice. If it is possible to err in morals, this is because the mind is liable to err in science, and not to see things as they actually are. To err in morals is but to affirm practically a false position: hence the act may be evil, but the agent is not culpable, since his error is involuntary. Lastly, Wollaston maintains that his theory, far from being inconsistent with the acknowledged characteristics of the idea of moral good, affords the only just explanation of them. The truth is immutable, because it expresses the unchangeable nature

of things, and therefore the ideas of moral good are immutable. Hence, too, the same eternal distinction between moral good and evil as between truth and falsehood. Whatever, in short, may be predicated of truth, is applicable to the moral principle; and its foundations are as valid and imperishable as those of science itself. (*The Religion of Nature.*)

The other form of the rational theory, which explains the idea of good to be an immediate conception of the intuitive reason, intelligible in itself, and incapable of definition, now remains for elucidation. According to Cudworth (born 1617, died 1688), certain universal and absolute ideas exist from all eternity in the divine mind; the human intellect, therefore, as emanating from the divine mind, by its nature possesses these ideas antecedently to experience. They remain dormant, it is true, until outward objects call them forth; but when once awakened, they immediately apply themselves to things, and give them a significant character, which in themselves they do not possess. Cudworth's chief object in advancing this theory was to exempt the ideas of right and wrong from the arbitrary and relative character with which the sensuous doctrines of Hobbes had invested them. Accordingly, he shows that no relation of human will or pleasure can constitute these ideas. Positive laws, he urges, do not oblige by their mere enactment, but by virtue of the natural ideas of justice and obligation which they imply. Neither is this idea the mere creature of man's reason, for reason does but conceive the idea, and, by applying its unchangeable standard to actions and characters, appreciates and judges them. Lastly, this idea is simple and indefinable, and inseparably combined with that of obligation. Hence every virtue assumes the character of a duty, and is as unalterable as good itself. (*Eternal and Immutable Morality.*)

Price (born 1723, died 1791) ascribes all simple ideas to two faculties—sense and understanding. The latter sees things as they are; the former perceives only the effects which they produce on the sensuous organisation. The ideas of the understanding consequently express realities which are independent of man, whereas those of the sense are feelings which would be different if man's sensuous organs were changed. Now the question of the objective reality and immutability of the ideas of right and wrong reduces itself to the enquiry into their origin. According to Price, they belong to the understanding as a faculty of intuition or immediate power of perception, distinct from the understanding as a reasoning or deductive faculty. The doctrine which would assign them to sensation as their origin has its source in the fact that the moral perceptions are invariably attended with agreeable or disagreeable emotions, and in the exclusive consideration of this circumstance. But when men declare gratitude to be a virtue, and ingratitude a vice, they intend to signify not merely that they produce emotions in their own minds, but that they are naturally virtuous and vicious in themselves. If by virtue and vice nothing more be meant than certain mental affections, then, in that case, our moral judgments would be infallible, and the same act might with equal truth be the subject of the most conflicting estimates, and all things would be indifferent in their own nature, since the understanding, which alone apprehends things as they are, could see in them neither good nor evil. Moreover, in this case, they would be without authority; for what obligation can there be to do what is pleasing, or to forbear what is displeasing? But these ideas are both immutable and imperative: they are immutable, since they are real qualities of actions, and every real quality is a part of the nature of things, which is immutable. God may destroy the things themselves, but He cannot cause them to be what they are not. After establishing the rational origin and immutable character of the moral perceptions, Price proceeds to explain the manner in which they are apprehended by the intuitive reason. As any event suggests the idea that it must have taken place in time, and thereby we arrive at the idea of duration, in the same way certain actions of free and rational agents are immediately apprehended to be good or evil, and the ideas of right and wrong arise in the consciousness. As to the notions of moral beauty and deformity, these we ascribe to good and evil actions in virtue of the pleasure and pain which accompany, but yet are distinct from, the perception of right and wrong. In contemplating the actions and affections of moral agents, we have both a *perception of the understanding* and a *feeling of the heart*; the latter are the effects of the former, and partly depend on the positive constitution of our nature, and partly on the essential congruity of object and faculty. The former are wholly inexplicable, and the only account we can give of them is—such is our frame; so God has seen fit to make us. But there are some objects and ideas which have a natural fitness and unfitness to please our mind; and such is the nature of certain actions that when they are perceived by a rational being, there must result in him certain emotions and affections. These are at first of a purely intellectual kind; but, as such, they are too weak to govern and actuate man, and they are therefore combined with a stronger excitement, and we are endowed with certain special instincts which impel us to goodness, and by means of these we are effectually moved towards their proper objects. As to duty or obligation: this idea is so intimately allied to that of good, that one cannot appear without the other. It is not plainer that figure implies something figured, than that rightness implies oughtness. Rewards and punishments suppose in their very idea moral obligation, and are founded upon it. They do not make it, but enforce it, or furnish additional motives to comply with it. They are the *sanctions* of virtue, but not its *efficients*. The ideas of good and ill desert are equally immediate; for they

are really nothing less than a species of the ideas of right and wrong; although there is this difference in them, that while the latter are properly ascribed to actions, merit and demerit are applicable to agents or persons only. We have an immediate approbation of making the virtuous happy, and discouraging the vicious, apart from all consequences. The conception of virtue is totally distinct from the fact that virtue is a source of pleasure; for it is one thing to find by experience that the tendency of virtue is to the happiness of the world, and vice to its misery, and another to conceive that virtue is by a necessary truth deserving of happiness. Neither does it result from the view that virtue is of public utility; for, even though this consideration may incline us to wish good to the virtuous, yet are we antecedently moved to the same wish by the more immediate and more simple consideration that he is virtuous, and as such, without any other consideration, we pronounce him deserving of honour. Lastly, Price makes liberty and intelligence to be essentially necessary to the morality of the agent, and distinguishes absolute virtue, which is to act voluntarily and consciously in conformity with the moral laws, from practical virtue, or acting on a belief of good in supposed conformity to good. (*View of Principal Questions and Difficulties in Morals.*)

Stewart (born 1753, died 1828) distinguishes two questions in the fundamental problem of ethics—that of the nature of good, and that of the faculty which discerns and judges of it. With respect to the first, he teaches that upon observation of certain actions the idea of good arises in the mind. This idea represents a certain quality of the actions themselves, and inherent in them, like the primary qualities of bodies, and therefore independent of the sensuous percipient, and not, like the secondary qualities, mere relations between us and the actions. As to the nature of these qualities, they are, like the ideas which we have of them, perfectly original, simple, and irreducible, and consequently indefinable. He further shows, after Price, that it is impossible to explain the terms *good* and *evil* except by synonyms, or by substituting for the ideas which they represent some of the circumstances which accompany the perception of them. As to the second question, Stewart argues that good being a simple and real quality in actions, it is impossible to refer the idea of it to any faculty which is not a source of original ideas, and which does not apprehend the real and inherent qualities of objects. It is, therefore, impossible to refer it to a sense (such as that of taste or smell) which reveals, not the real nature of objects, but only the effect which they produce in the perceiving subject; nor to reason—if by this term we understand nothing more than the faculty which seizes the relations and deductions of ideas previously established, because the idea of good is simple and original, and not one of relation and consequence; but if by sense we understand a faculty analogous to that which perceives the primary qualities of bodies and their existence—or if by reason we mean the intuitive understanding which furnishes the simple, primary, and original ideas of time, space, and causation—then the ideas of good and evil may be referred to either. If Stewart inclines, nevertheless, to favour the claims of reason, he yet declares the question to be unimportant when once it has been admitted that good and evil are simple and indefinable. (*Philosophy of the Active and Moral Powers.*)

In this exposition, the first object has been to give a correct and impartial view of the several theories which have been proposed of the nature of virtue and of the moral perceptions. Their comparative merits are left to the judgment of the reader. (Cf. Ritter, *History of Ancient Philosophy*; Mackintosh, *Dissertation on Ethical Philosophy*; Schleiermacher, *Kritik der Ethik*; Jouffroy, *Droit Naturel*; Cousin, *Cours de Philosophie Morale*; Bain, *The Senses and the Intellect*, *The Emotions and the Will.*) [SCHELLING, PHILOSOPHY OF.]

Ethionic Acid. May be viewed as the bisulphate of the diatomic radical ethylene. It is ethylene united with two equivalents of water, and four of sulphuric acid.

Ethiopian Language. The Ethiopian language, properly so called, survives only in books. It belongs to the Semitic class of languages, bearing a close affinity to Arabic, but is written from left to right. The literature extant in this tongue is almost wholly biblical and ecclesiastical. The Old and New Testament was translated into Ethiopian from the Alexandrian text about the fourth century. The Ethiopic version of the apocryphal Book of ENOCH [which see] was found during the last century by the African traveller Bruce.

Ethiops Mineral. The black powder obtained by rubbing mercury with sulphur.

Ethmoid (Gr. ἠθμός, *a strainer*, and εἶδος, *form*). The ethmoid or cribriform bone. A bone of the head enclosed in the *os frontis* between the orbitary processes; it is very light and spongy, and consists of a network of convoluted plates.

Ethnography. [ANTHROPOLOGY.]

Ethnology. [ANTHROPOLOGY.]

Ethyl or **Ethule.** A name applied to the organic radical ($=C_4H_5$) contained in ether and alcohol. Ethyl is best obtained by the action of zinc upon iodide of ethyl. It is at ordinary temperatures a colourless and invisible gas, possessing a very slight ethereal odour and burning with a brilliant white flame. Its specific gravity is 2·0039. Exposed to a pressure of $2\frac{1}{4}$ atmospheres it condenses to a colourless and mobile liquid.

Ethylamine. A powerful, caustic, artificial organic base, volatile and liquid, and derived from ammonia by replacement of three equivalents of hydrogen by three of ethyl.

Ethylcarbonic Acid. [CARBETHYLIC ACID.]

Ethylene. [OLEFIANT GAS.]

Etiolation. That condition of a plant in which all the green colour is absent. Such a state is produced by want of light. When it is artificially obtained by keeping plants in the dark in order to insure their being more tender and insipid than is natural to them, it is called *blanching*, as in the case of celery. Etiolated parts become green by exposure to light.

Etiquette (Fr. *a ticket*). The ceremonial code of polite life, more voluminous and minute in each portion of society according to its rank. The word is derived from the custom of arranging places at processions, &c. by tickets delivered beforehand to applicants. The Byzantine court appears to have carried the practice of ceremonial observances to the greatest extent. But of modern courtly etiquette, Philip the Good, duke of Burgundy, is regarded by some as the founder. At no time, probably, was the spirit of etiquette so predominant and so tyrannical as in the court of Louis XIV. (*Memoirs of Saint Simon.*) The smaller courts of Germany caricatured the ceremonial of that of the Great Monarch, and carried its strictness to an absurd extent. At the present day the ancient etiquette of courts is continually losing something of its strictness.

Étoile (Fr. *a star*). In Heraldry, a star which differs from a mullet in its number of points, and four of the points being rayant.

Etruscan Language. The language of the people of ancient Etruria. Its philological place has not yet been determined. It has been assigned by some to the Keltic class of languages; but even the affinity of the Etruscans with the Keltic tribes cannot be positively maintained. The Etruscan was read from right to left.

Etymologicum Magnum. A valuable vocabulary of the Greek language, by an unknown author. It contains many traditions respecting old or uncommon words. Sylburg's edition (1594) has a good index; the edition of Schäfer (Lips. 1816) is a reprint of that of Sylburg. Sturz also edited an edition, Lips. 1818, 4to.

Etymology (Gr. ἐτυμολογία, from ἔτυμος, *true*). The science which treats of the origin or root of individual words, and of the relation borne respectively by their several meanings to that origin. It is a branch of the general science of philology. [PHILOLOGY.]

Eucalyptus (Gr. εὖ, *well*, and καλύπτω, *to cover*). This genus of *Myrtaceæ* furnishes the gigantic Gum-trees and Stringy Barks of the Australian and Tasmanian forests. These trees are sometimes of enormous size, and the timber is of excellent quality. *E. gigantea*, the Stringy Bark, has been known to yield specimens upwards of 300 feet high, and 100 feet in girth at a yard from the ground. The Blue Gum, *E. globulus*, however, yields the most valuable timber, which is much used by shipbuilders, millwrights, &c., and by engineers in the construction of works requiring beams of great size. *E. resinifera*, and other species, yield a red astringent gum, resembling kino; *E. piperita*, an essential oil; and *E. Gunnii*, the Tasmanian Cider-tree, a cool refreshing liquid upon incision of the bark in spring.

Eucharist (Gr. εὐχαριστία). A term signifying properly *giving of thanks*, but generally used in theological language to denote the sacrament of the Lord's Supper. The celebration of this rite is derived from the account given by the Evangelists of the action of our Lord in offering to the apostles bread and wine, adding at the same time, 'Do this, as oft as ye shall do it, in remembrance of Me.' This commemoration is spoken of in the New Testament, and by the Fathers, as a sacrament and a mystery. For the solution which the Roman Catholics give for this mystery, see TRANSUBSTANTIATION; and for that of the Lutherans, see CONSUBSTANTIATION.

According to the doctrine of the Anglican church, an inward and spiritual grace is conveyed in the Eucharist to those who partake of it; but many Protestant bodies conceive the communion to be nothing more than an outward act of obedience enjoined as a commemorative ceremony, and only instrumental to salvation in the same way as any other act of obedience. [SACRAMENT.]

Euchlorine (Gr. εὔχλωρος, *bright green*). A name given by Sir H. Davy to the oxide of chlorine, in consequence of its deep yellow-green colour.

Euchology (Gr. εὐχολόγιον). A book of prayers; synonymous, in the phraseology of the Roman Catholic church, with *missal* or *breviary*.

Euchroic Acid (Gr. εὔχροος, *of a fine colour*). One of the products of the destructive distillation of mellitate of ammonia. It is crystalline, and gives a beautiful blue colour (*euchrone*) when placed in contact with zinc.

Euchysiderite (made up from Gr. εὖ, *well*; χέω, *I fuse*; σίδηρος, *iron*). A silicate of lime, magnesia, and protoxide of iron. A species of *pyroxene*.

Euclase (Gr. εὖ, *well*, and κλάω, *I break*). A silicate of alumina and glucina, found in small greenish crystals, in Peru and Brazil, and in auriferous sands, near the river Sanarka, in the South Ural. Though well suited for jewellery, on account of its great hardness, and the fine polish which may be given to it, this stone is seldom used as a gem in consequence of its rarity and fragility.

Eucrasy (Gr. εὐκρασία). A well proportioned mixture of qualities, by which a body is said to be in good order, and disposed for a good state of health.

Eudialite (Gr. εὐδιάλυτος, *easily dissolved*; from the facility with which it is dissolved in hydrochloric acid). A silicate of zirconia, lime, and soda, with the oxides of iron and manganese, found on the west coast of Greenland.

Eudiometer (Gr. εὐδία, *calm air*, and μέτρον, *measure*). This term is generally applied to instruments used for the analysis of atmospheric air and other gases. [GASOMETRIC ANALYSIS.]

Euergetes (Gr. *a benefactor*). A title of honour frequently bestowed by the Greeks on those who had served the state well, and given more especially to some of the Egyptian Ptolemies. Reference is made to this practice in St. Luke xxii. 25.

Eugenia (in honour of Prince Eugene of Savoy, an eminent patron of botany). A genus of *Myrtaceæ*, consisting of tropical American or West Indian trees and shrubs, the most important of which is the *E. Pimenta*, the unripe sun-dried fruits of which are Allspice. This tree is much cultivated in the West Indies. *E. cauliflora* furnishes the Jabuticaba fruits of Brazil; and *E. malaccensis* and *E. Jambos*, the famous Rose-apples of the East.

Eugenine. A crystalline substance extracted by alcohol from cloves.

Eugubine Tables. By this name are known certain bronze tablets, found in 1444 near the ancient Eugubium, now Gobbio. Of the inscriptions, five are in Umbrian and Etruscan character, the two others being in Latin. In the opinion of Sir G. C. Lewis, no attempts to interpret them have been successful; but Professor F. W. Newman seems to have traced clearly the connection of many of the Umbrian words with their Latin forms.

Eukairite (Gr. εὔκαιρος, *opportune*). A selenide of silver and copper. This rare mineral has been met with only at the copper mine of Skrickerum in Norway, and lately in Chili in the Cordilleras of Copiapo and at the mines of Flamenco north of Tres-Puntos. Berzelius, by whom it was originally discovered and analysed, gave it the name of Eukairite in allusion to its discovery soon after the completion of his examination of selenium.

Eulabes (Gr. εὐλαβής, *cautious*). A genus of Passerine birds, belonging to the family of thrushes, and distinguished by having broad strips of naked skin on each side of the occiput, and a bald spot on the cheek. The bill nearly resembles that of a thrush; their nostrils are round and smooth. The species are termed *Mainates* by the French ornithologists; and the Javan *mainate* (*Eulabes javamens*) of all birds is said to imitate most completely the language of man.

Eulerian Integrals. The name given by Legendre in his *Exercices de Calcul Intégral*, vol. ii., to two important definite integrals, whose properties were first signalised by Euler in his *Institutiones*. The *first Eulerian integral* is

$$\int_0^1 x^{m-1}(1-x)^{n-1}\,dx,$$

for which Binet has proposed the symbol $B(m, n)$ or $B(n, m)$, since by substituting $1-z$ for x it may be easily shown that the above integral is equal to

$$\int_0^1 z^{n-1}(1-z)^{m-1}\,dz.$$

The *second Eulerian integral* is

$$\int_0^\infty e^{1x} - x^{n-1}\,dx,$$

an equivalent form of which is

$$\int_0^1 \left(\log\frac{1}{y}\right)^{n-1} dy.$$

The symbol proposed by Legendre, and now generally used, for this second transcendental is $\Gamma(n)$, on which account it is frequently called the GAMMA-FUNCTION [see the term]. The two Eulerian integrals are connected by the relation

$$B(m, n) = \frac{\Gamma(m).\Gamma(n)}{\Gamma(m+n)}.$$

Of this and of other properties of Eulerian integrals, demonstrations will be found in any good treatise on the Calculus.

Eulima. A genus of marine shell-clad Gastropods, whose characters are *shell* turreted, acuminate, with many whorls; aperture ovate, acuminated posteriorly; outer lip thickened and bearing numerous obsolete *varices* or wart-like processes; operculum horny, thin, and with its nucleus anterior.

Eulogy (Gr. εὐλογία, *praise*). In a general sense, an encomium pronounced on any person; but, in a more restricted meaning, it was used in Ecclesiastical History to denote any present bestowed on the church after having been *blessed* or *hallowed*.

Eulytine (Gr. εὔλυτος, *easily loosed*). A mineral found at Freiberg, composed of silica, oxide of bismuth, and alumina.

Eumenides (Gr.). In Greek Mythology, this name, significant only of gentleness, was given by euphemism to the Erinyes. [ERINYS.] By later poets the name was confined to the three sisters commonly known as the Furies, Allecto, Megæra, and Tisiphonê.

Eunice (Gr. Εὐνίκη, the name of a Nereid). A genus of marine Dorsibranchiate Anellidans, having tufted branchiæ, and a mouth armed with three pairs of horny jaws. One species (*Eunice gigantea*) attains the enormous length of between four and five feet.

Eunomia (Gr.). One of the small planets belonging to the group between Mars and Jupiter. It was discovered by M. de Gasparis at Naples on the 29th of July, 1851, and is the fifteenth in order of discovery. At its discovery it appeared like a star of the ninth magnitude.

Eunuch (Gr. εὐνοῦχος, literally *one who has the care of a bed-chamber*). A term applied to those who have been subjected to the operation of castration. This practice seems to have originated in the jealousy which prevails in Eastern countries. As far back as the time of Herodotus, it was carried to a great extent by the Persians, who not merely intrusted to eunuchs the care of their wives and daughters, but considered them in every respect as more trustworthy than others. In the middle ages the 'chief of the eunuchs' was one of the most important functionaries of Eastern government; and the seraglios of these countries are superintended by eunuchs even in the present day. In modern times the loss of virility is in some countries believed to preserve and improve

the voice; and hence, especially in Italy, this operation is or was practised upon children intended to supply the operas of Europe with singers. Zeal for religion has also caused many persons to undergo this operation. As early as the third century there arose a class of enthusiasts, who, animated by the example of Origen, not only castrated those of their own persuasion, but even all persons on whom they could lay their hands. Several of the Christian Roman emperors instituted severe prohibitions against this revolting practice; and at a later period the council of Nice excluded from the pale of the church all who, actuated by whatever motives, had allowed themselves to be thus mutilated.

Euonymus, sometimes written **Evonymus** (Gr. εὐώνυμος, literally *of good name*, a euphemism for *hurtful* or *unlucky*). A genus of shrubs or small trees of the order *Celastraceæ*, the common species of which, *E. europæus*, called Skewerwood or Prickwood, yields a strong compact easily-worked light yellow wood, applied to many useful purposes, and from which a kind of charcoal is made, much approved by artists. The foliage, flowers, and fruit are poisonous, though the last are sometimes used as a dye. The orange-coloured arillus disclosed by the bursting of the bright rose-coloured capsules gives the plant in autumn a very striking appearance.

Eupatorium (Gr. εὐπατόριον). The name in common use for a genus of *Compositæ*, one species of which, *E. perfoliatum*, is a valuable tonic stimulant, used as a substitute for Peruvian bark in the cure of intermittent fevers in the United States, where it is a native; *E. Ayapana* of South America is reputed to be a powerful sudorific. The name is sometimes given to the herb Agrimony (*Agrimonia Eupatoria*), in common use in Holland as an alterative.

Eupatridæ (Gr. εὐπάτριδαι). In Ancient History, the nobles of Attica, in whose hands in early times all the power of government was so vested that the lower orders sank into a state of degradation under the pressure of debt, which, if not paid, gave the creditor power over the bodies and liberties of the debtor and his family. These evils were remedied by the legislation of Solon, who reduced the interest of debts, and deprived the creditor of his power over the body of the debtor, while at the same time he threw the judicial and much of the legislative power into the hands of the people at large or Demus (Δῆμος). Later alterations in the constitution of Athens by degrees deprived the Eupatridæ of all their political privileges, and finally established an unmixed democracy.

Eupepsia (Gr.). Good digestion. [DYSPEPSIA.]

Euphemism (Gr. εὐφημισμός). A figure in Rhetoric, by which one expression is substituted for another, which conveys, through some association of ideas, an image offensive to the hearer or reader. But the euphemisms of the heathen world generally spring from a desire of deprecating the wrath of malignant beings, by attributing to them characteristics opposite to those which really belong to them. Thus, the Furies were, by the Greeks, termed Eumenides, *gentle*, while the Black Sea was called Euxine, or the *hospitable*.

Euphony (Gr. εὐφωνία, *goodness of voice* or *rhythm*). In contradistinction to CACOPHONY [which see]. That quality in language which results from happy combinations of the enunciative elements; such especially as, though essentially different in their characteristic powers, melt easily into each other, so as to preserve an uninterrupted flow without labour to the speaker or offence to the hearer.

Euphorbia (after Euphorbus, physician to Juba, king of Mauritania). A large and diverse family of acrid plants, typical of the *Euphorbiaceæ*. They are milky plants, mostly herbaceous, sometimes shrubby, and not unfrequently succulent and leafless, and then having very much the aspect of *Cacti*. The most important product of the genus is *Euphorbium*, an acrid resinous drug, obtained from certain succulent species, as *E. officinarum, canariense*, and others. The roots of *E. Ipecacuanha, Pithyusa*, and *Gerardiana* are emetic. *E. Cattimandoo*, an Indian plant, furnishes a kind of Caoutchouc. Though generally acrid and more or less poisonous, some species are edible. Thus *E. edulis* forms a potherb, its acridity being dissipated by boiling.

Euphorbiaceæ (Euphorbia, one of the genera). A very extensive natural order of diclinous Exogenous plants, found in almost all parts of the globe. Among the diclinous orders, they are known by their scattered flowers, their tricoccous fruit, and their definite suspended anatropal ovules. Their sensible properties are, on the whole, poisonous and exciting, being both of a volatile nature and often dispelled by heat. Thus the stem of *Manihot utilissima* or *Cassava*, which, when raw, is poisonous, becomes a wholesome food when roasted. In the seeds the albumen is harmless, but the embryo is acrid. The seeds of *Ricinus communis*, which by pressure yields Castor Oil, and those of *Croton Tiglium* are purgative; as are the leaves of the Common Box, *Buxus sempervirens*. The bark of several species of *Croton*, the wood of *C. Tiglium*, and of *Buxus*, and the leaves of *Cicca disticha* and several *Euphorbias* are sudorific. The root of various Euphorbias, and the juice of *Commia, Mercurialis*, and others are emetic. Caoutchouc is abundantly furnished by *Siphonia elastica*; and the aromatic Cascarilla bark is the produce of *Croton Eleutheria*.

Euphorbium. An acrid gum resin, the produce of *Euphorbia officinarum* and other species; it is virulently purgative and emetic, and the dust of it is dangerously stimulant to the nose.

Euphotide (Gr. εὖ, and φῶς, *light*). A rock consisting of felspar and diallage. It is the *gabbro* of the Italian artists.

Euphrasia (Gr. *good cheer*). A genus of Scrophulariaceous plants, including the *E. officinalis* or Eyebright, which is a popular remedy for weak eyes, and is also an ingredient in British herb tobacco.

Euphrosyne. [CHARITES.]

Euphuism. An affected style of speaking and writing, which became a fashion during the reign of Queen Elizabeth. The taste of an age which was gradually becoming conscious of the powers of the English language, tended to a love of affected conceits, which was carried to absurd lengths by John Lilly in his *Euphues* (Gr. *graceful or witty*). The extravagant antitheses and illustrations of this worthless book were received with delight by critics who worshipped the 'curious invention' of the author. This style has been ridiculed by Shakspeare and Ben Jonson; but it should be remembered that Sir Walter Scott's imitations introduced into his romance *The Monastery* preserve little of its real character. (Hallam, *Literature of Europe*, part ii. ch. vii.)

Eupion (Gr. *very fat*). A very limpid liquid which stains paper like oil, and which exists in the tar produced during the destructive distillation of many animal and vegetable substances. Its specific gravity is 0·74, and it boils and evaporates at 340°. It is insoluble in water, but dissolves in ether and alcohol. It is insipid and inodorous, but highly inflammable.

Eupyrion (Gr. *εὖ*, and *πῦρ*, *fire*). A term applied to several contrivances for obtaining instantaneous light; such as lucifer matches, &c.

Eurite or **White Stone** (Gr. *εὐρύς*, broad). A fine-grained granite, in which felspar predominates.

Euroclydon (Gr. *εὐροκλύδων*). A violent wind, mentioned in Acts xxvii. The name seems to signify a storm from the east; but the readings vary greatly, and among these variations occurs the form *εὐρακύλων*, in the Latin Vulgate, Euro-aquilo, the north-east wind.

Europa (Gr. Εὐρώπη). In Greek Mythology, the daughter of Agenor and Telephassa, and sister of Cadmus the founder of Thebes. According to some legends her birthplace was in Phœnicia. Thence she was carried away by Zeus or Jupiter in the form of a white bull, and became by him in Crete the mother of Minos, Rhadamanthus, and Æacus. ('Comparative Mythology,' in *Oxford Essays* for 1856, p. 61.) The legend has been rationalised by Herodotus, i. 3. The name seems to belong to the class which includes such epithets of the dawn as Euryanassa, Eurydike, Euryphaessa, Eurymedusa, &c.

Europe. This western division of the northern part of the great continent, is the smallest of the political divisions of the world once called continents, and is not geographically distinguished or naturally separated either from Asia or Africa. The Ural Mountains, which separate it nominally from Asia, are low and unimportant, barely commanding a watershed; the Mediterranean, that disconnects it from Africa, properly belongs entirely to it, together with the great chain of the Atlas. The mountain axis through Asia is continued entirely through Europe. The rivers of Europe are subordinate and inconsiderable, compared with those of Asia and America. The lakes are also small in comparison with those of the other great districts, but they are interesting and picturesque. Including its adjacent islands, the whole area of Europe is but three and three-quarter millions of square miles, and is only a little larger than Australia.

But there is one peculiarity of Europe, so marked and so important in its influence on man, as fully to explain its great advantages over other countries in some respects, and its present condition as the centre of the most progressive forms of civilisation. With so small an area as that described, and attached as it is to Asia by a long land frontier, the coast line of Europe is so wonderfully indented and broken by inland seas, gulfs, bays, and inlets, that its length is nearly 20,000 miles. The total estimated length of coast of all the land on both sides of the great Atlantic canal, including the inland seas, being little more than 55,000 miles, the enormous preponderance of European coast compared with that of an equal area of other lands may be easily understood. The north and west coast of Africa, the whole eastern coast of the two Americas, and the shores of the great gulfs of Mexico and the Caribbean Sea have together a length of coast less than double that of the west and south shores of Europe.

Europe possesses mountain ranges, river systems, lakes, plateaux, and low plains. All are deeply interesting and instructive, though so much smaller than those of the larger tracts of land. We proceed to notice briefly the chief outlines, referring to separate articles for those which possess special interest.

Mountain Chains.—The great and commanding mountain axis of Europe is the chain of the ALPS; culminating towards the west between Switzerland, France, and Italy by the Mont Blanc and Monte Rosa groups, attaining a nearly equal elevation in the Oberland Alps, continuing at great elevation eastwards through the Tyrol to the Gross Glockner, continuing at lower elevation towards the east to connect with the CARPATHIANS, branching to the south-east to form the APENNINES, and afterwards the Dalmatian Alps extending into Greece and connecting with the BALKAN. The western continuation of the Alps forms the great chain of the PYRENEES.

The other mountain chains of Europe are the Scandinavian chain, continued into Scotland, Cumberland, and Wales; the Sierra Nevada, in Spain; the Vosges, and the mountains of the Black Forest, the Harz, the Erzgebirge, Fichtelgebirge, Riesengebirge, and some others. The mountains of Central France form a group rather than a chain.

The following are the heights of the culminating peaks of the principal chains:—

Name of Chain	Name of Mountain	Height ft.
Alps	Mont Blanc	15,760
Sierra Nevada	Muley Hassan or Mulhacen	11,660
Pyrenees	Maladetta	11,168
Balkan	Tchar Dagh	10,000
Apennines	Monte Corno	9,523
Carpathians (Tatra group)	Lomnitz	8,779
Pindus	Guiona	8,239
Dovra-feld	Snae-hattan	8,122
Riesengebirge	Schnee-koppe	5,000
Grampians	Ben Nevis	4,368
Cambrian	Snowdon	3,571
Mackgillicuddy's Reeks	Carn Mal	3,410

River Systems.—Of the river systems of Europe, the Danube is by far the most important; but it has only a secondary drainage, emptying into the Black Sea, which communicates with the great ocean through the whole course of the Mediterranean. Of the rivers entering the Atlantic, the Rhine is the principal.

The water systems of Europe are eminently favourable to navigation; for although the rivers are smaller than those of Asia and America, they are in all respects more useful and available. Most of them are now navigated by steamboats for a great distance into the interior of the continent, and some are made to communicate by artificial canals, so as to permit a complete internal system of water traffic.

The mountain axis acts as a complete water parting in Europe. No stream crosses the axis at a high level; and the only large river that runs north and south, and occupies transverse valleys, is the Rhône, which separates the Alps from the Pyrenees. The Danube indeed separates the Carpathian branch from the main chain; but it is bent aside by the Dalmatian Alps and the mountains of Greece, and no other river crosses any part of the main chain. The water systems of Europe are thus either north or south of the mountain axis, and the largest number and the most important are to the north. Except the Rhine and the rivers of France, all empty themselves into the Baltic; the direct Atlantic drainage being therefore very small. The drainage south of the mountain axis is chiefly into the Mediterranean and its smaller seas; but several of the rivers of the Spanish peninsula enter the Atlantic.

Except the Danube and the Volga (which is only partly a European river), the drainage areas in Europe are small. [RIVER SYSTEMS.] Of the various rivers, several have deltas; these are very extensive in the case of the Rhine, the Rhône, and the Danube. [DELTA.]

Lakes.—There are in Europe several lakes large in proportion to the area of the land, but small compared with the principal lakes of the earth. Lake Ladoga is the largest, having an area of about 1,400 square miles. It communicates with the gulf of Finland. There are several smaller lakes at no great distance. The Swiss and Italian lakes, though not large, are remarkable beyond all others for the exquisite and magnificent scenery surrounding them. They are all of fresh water, and are some of them deep mountain lakes, others being shallow and occupying mere depressions in the plains.

Plateaux and Low Plains.—The great plateau of Europe is the high land of the Iberian peninsula between the Pyrenees and the Mediterranean. It is flanked by short mountain chains crossing the country in various directions. The area of this table land is not less than 100,000 square miles. High land extends also through the middle of France. No elevated table lands occur in the Alps, although the great valley of Switzerland is much elevated above the sea. There is table land in and near Greece.

The low plains of Europe are very extensive on the north side of the mountain axis, and are only interrupted by mountains of secondary importance. They are almost continuous from the shores of the German Ocean and the Baltic to the foot of the Ural Mountains, and others extend southwards and connect with the extensive low lands of Asia. The greater part is very level, and not very much above the sea. [STEPPES; PLATEAUX.]

Eurydice. [ORPHEUS.]

Eustachian Tube. Named after the celebrated Italian anatomist Bartholomew Eustachius, who is said to have discovered it, though it is accurately described by Aristotle, who quotes an earlier Greek anatomist, Alcmeon, as having known it. This communication between the ear and the mouth begins in the anterior part of the tympanum, and runs in a bony canal forwards and inwards, terminating with the petrous portion of the temporal bone. It then proceeds, partly cartilaginous and partly membranous, gradually enlarging to its termination behind the soft palate. It is through this tube of communication with the ear that persons who have a perforated tympanum blow tobacco smoke: when the Eustachian tube is stopped, or obliterated, it produces deafness. [EAR.]

Eustachian Valve. A semilunar membranous valve, which separates the right auricle of the heart from the inferior *vena cava*, first described by Eustachius.

Eustathians. In Ecclesiastical History, a sect of heretics of the fourth century; so called from their founder Eustathius, a monk whose opinions were condemned at the council of Gangea.

Eustyle (Gr. εὔστυλος). In Architecture, that intercolumniation, or space between columns, which, as the name imports, was considered the most beautiful, being two diameters and a quarter of the column in width.

Euterpe (Gr. εὐτερπής, *delightful*). A genus of graceful habited Palms found in the tropical parts of South America. *E. edulis* is the Assai Palm of Pará. It grows in swampy places, reaches thirty or forty feet in height, and bears fruit from which the natives manufacture Assai,

a beverage of a thick creamy consistence and of plum colour, which, when sweetened with sugar and thickened with cassava starch, is very nutritious.

Euterpe (Gr.). In Mythology, one of the nine Muses. (Horace, *Ode* 1. l. 54; Hesiod. *Theog.* 77.)

Euthanasia (Gr. from εὖ, and θάνατος, *death*). Literally, an easy death. By political writers it is employed in various senses to indicate such peculiar theories as have the best tendency to uphold the state or disentangle it from difficulties. Thus, for instance, it is maintained that the issue of inconvertible paper money is the true *euthanasia* of public debts in modern countries.

Euthyne. [Dokimasia.]

Eutychians. In Ecclesiastical History, a sect of the fifth century, marked by the vehemence of their opposition to the heresy of the Nestorians. The latter had asserted the distinctness of the two natures in Christ; the Eutychians confounded them together, and supposed the human to be merged in the divine. Their originator, Eutyches, was the abbot of a monastery at Constantinople, and was excommunicated in the year 448 by a synod which was convened there for that purpose. This decision was controverted by another council at Ephesus in the following year; but the new opinions were finally condemned by the council of Chalcedon in 451, which established the doctrine that Christ was perfect God and perfect man, consubstantial with the Father as to His divinity, and with man as to His humanity, the two natures being united in Him without conversion, without confusion, and without division.

Euxanthic Acid. *Purreic acid.* The pigment known as *Purree* or *Indian yellow* is the magnesia salt of purreic acid. Purreic acid forms pale yellow crystals; by heat it gives a sublimate of *euxanthone* (*purrenone*), and by the action of sulphuric acid yields *hamathionic acid.*

Euxanthine (Gr. εὖ, and ξανθός, *yellow*). A substance obtained from India under the name of *Purree* or *Indian yellow.* It is supposed to be derived from the bile or urine of the camel, buffalo, or elephant: it forms small pale yellow crystals.

Euxenite (Gr. εὔξενος, *friendly*). A mineral containing columbium, yttria, and uranium, found at Arendal in Norway.

Evangelical (Gr. εὐαγγελικός, from ἄγγελος, *messenger*). A title assumed by different branches of different Protestant churches, by way of marking their peculiar orthodoxy. In Prussia, the United Lutheran and Calvinistic churches have styled themselves the *Evangelical church.*

Evangelist (Gr. εὐαγγελιστής). One who brings good tidings. Hence the authors of the Four Gospels are called *evangelists.*

Evaporation (Lat. evaporatio). The conversion of substances into vapour is one of the most important and general effects of heat. During this process, a considerable quantity of sensible heat passes into the *latent* or insensible state. When a vessel of water is placed upon the fire, its temperature gradually rises till it attains 212°; then, although it remains upon the fire, and of course receives heat as before, it does not become hotter, but is gradually converted into steam or vapour: so that the effect of heat is not to elevate temperature, but to change state or form; that is, in the case of water, to convert it into steam. Hence we assume that steam, though not hotter than water, contains a much larger quantity of heat, and this heat again makes its appearance when the steam is condensed or re-converted into water. At whatever temperature vapour is produced, it is similarly constituted; and that which escapes from water at ordinary temperatures, by the process usually called *spontaneous evaporation*, resembles the former in all respects: hence it is that evaporation is to surrounding bodies a cooling process; and that in the converse change, or the return of the vapour to the liquid state, heat is evolved and rendered sensible. The same general phenomena are observed with all other liquids, and those which evaporate rapidly at common temperatures often give rise to the production of a great degree of cold; such as spirit of wine, or ether. If the latter fluid be suffered to dribble over the bulb of a thermometer, it will cause it to sink below the freezing point of water; and by accelerating similar cases of evaporation, we obtain most intense degrees of artificial cold.

The circumstances that principally influence the process of spontaneous evaporation are, extent of surface, and the state of the air as to temperature, dryness, stillness, and density.

Evectant. A peculiar kind of contravariant, formed by operating on any invariant of any quantic

$$a_0 x^n + n a_1 x^{n-1} y + n b_1 x^{n-1} z + \frac{n(n-1)}{1.2} a_2 x^{n-2} y^2 + \&c. \;. \;.$$

with the symbol

$$\left(\xi^n \frac{d}{da} + \xi^{n-1}\eta \frac{d}{da_1} + \xi^{n-}\zeta \frac{d}{db_1} + \xi^{n-2}\eta^2 \frac{d}{da_2} + \&c. \;. \;.\right)^p,$$

where the facients ξ, η, ζ . . . are contragredient to x, y, z. . . . Strictly speaking, the result of this operation should be called the p^{th} *evectant.* Thus the discriminant of the ternary quadric

$$ax^2 + by^2 + cz^2 + 2dyz + 2ezx + 2fxy$$

being

$$abc + 2def - ad^2 - be^2 - cf^2,$$

its first evectant is

$$(bc - d^2)\xi^2 + (ac - e^2)\eta^2 + (ab - f^2)\zeta^2 + 2(cf - ad)\zeta + 2(df - be)\zeta\xi + 2(dc - cf)\xi\eta,$$

which is known to be a contravariant. [Discriminant and Contravariant.]

Evection (Lat. evectio, *a carrying out*). In Astronomy, an inequality of the moon's motion, depending on the position of the transverse axis of the lunar orbit in respect of the line of the syzygies, or line joining the sun and earth. When the transverse axis lies in the same direction with that line, the quantity by which the solar force diminishes the gravitation of the moon is greatest when the moon is in the apogee, and least in the perigee. In this situation of the orbit, therefore, the difference between the moon's gravitation at her apogee and perigee is increased by the solar action, and the orbit consequently appears to have its eccentricity augmented. When the line of the apsides is in the quadratures, the contrary happens; the difference between the amount of gravitation at the apogee and perigee is diminished, and the eccentricity of the orbit appears also to be diminished. The evection is proportional to the sine of twice the angular distance between the sun and moon, diminished by the moon's mean anomaly; and its greatest value amounts to $1^\circ\ 20'\ 29{\cdot}9''$. This inequality (sometimes called the *second* inequality of the moon's motion, the equation of the centre being the *first*) was noticed by Hipparchus, and Ptolemy gave a construction which represents its general effects with great accuracy. The term *evection* was first applied to it by Bullialdus.

Even Keel. A ship is said to be on an even keel when she draws the same water abaft as forward; the expression, however, often implies, though inaccurately, *not inclined to either side*, or *upright*.

Evergreen. In Garden Botany, a name applied to those plants whose leaves remain perfect upon a stem beyond a single season, as the Holly, the Fir tribe, and the Ivy. [DECIDUOUS.]

Everlasting Flowers. Certain flowers, chiefly of the *Compositæ*, whose hard tissue and deficient moisture enables them to retain their colour for several months after having been gathered. [AMARANTHUS.]

Evidence (Lat. evidentia). In Law, 'any matter of fact, the effect, tendency, or design of which, when presented to the mind, is to produce a persuasion, affirmation, or disaffirmation, of the existence of some other matter of fact.'

A witness, in a court of common law, is compelled to give his attendance, in civil cases, by subpœna, or by habeas corpus if the witness be in custody. The reasonable expenses both of going and returning must be tendered to the witness when he is served with the subpœna. A witness, refusing to attend on subpœna, may be attached for contempt of court, and is liable to an action at the suit of the party damaged. In criminal cases, the attendance of a witness for the prosecution is enforced either by subpœna, or more usually by the magistrates who take the depositions in the first instance binding him over to appear. His expenses, in a case of felony, are insured to him by statute. The defendant may compel attendance of his witnesses by subpœna.

When the witness appears in court, objections may be taken to his competency. These objections are now reducible to two: want of understanding; want of religious belief. The first objection excludes persons of *non-sane memory* and also children too young or of too neglected education to understand the obligation of an oath: as to which they are questioned by the judge on the objection being taken. The second can now be sustained only in case of atheism or disbelief in a future state of reward and punishment: incompetency from interest, a principle derived from the civil law and formerly the source of much litigation, is now almost banished from our law; the only exceptions of importance being that by the Act 14 & 15 Vict. c. 99 a person charged with the commission of an indictable offence is not a *competent* witness, against himself. Several classes of witnesses, however, though competent, are not compellable: e. g. husbands and wives in criminal cases against each other: counsel and attorneys against their clients.

All testimony must be given under a judicial oath, with an exception only in favour of conscientious objections. [AFFIRMATION.]

Evidence, Immediate and Mediate.—Besides the exclusion of *witnesses* on the score of competency, large classes of *evidence* are inadmissible. Admissible evidence must be, in general, immediate; that is, it must convey the actual knowledge or belief of the witness. This rule excludes, as a general proposition, all hearsay; that is, all narration of the declarations made by others to the witness. There are, however, several classes of mediate testimony which are admissible. Such are, general reputation in certain cases; and declarations, made by a party to the suit, which contain admissions contrary to his own interest. So, in various cases, letters or entries made in books are admissible, where they contain similar admissions. Upon the same principle, the confession of a prisoner is evidence (if not extorted by fear or hope) in a criminal case. Depositions of a witness now deceased, but who had formerly given evidence on the same dispute, are admissible. Evidence may also be considered as divided into original or best, and secondary evidence. For instance, the reading of a document is better evidence of its contents than statements, either written or oral, respecting them. It is a general rule, that all secondary evidence is excluded, if better evidence (that is, evidence of a class which the law recognises as better) happen to be attainable.

Examination of Witnesses.—A witness, on being admitted in court, is first subjected to the examination of the party in whose behalf he is called, which is termed the *examination in chief*; and the principal rule to be observed by the party examining is, that leading questions are not to be asked. What are leading questions, it is not always easy to ascertain; but questions to which the answer Yes or No would be conclusive of the issue, fall undoubtedly within

this designation. All questions which suggest an answer may be considered, in one sense, as leading questions; but they are not all equally objectionable. The witness is then cross-examined by the opposite party. The object of cross-examination is twofold: to weaken the evidence given by the witness as to the fact in question, either by eliciting contradictions or new explanatory facts; or, secondly, to invalidate the general credit of the witness. In the latter case, it is a general rule, that a witness may refuse to answer any question, if his answer will expose him to criminal liability; and this, whether immediately or by collateral inference. Whether he can refuse to answer a question tending to disgrace him without involving him in danger, is a point which has been frequently debated, but which the general practice of our courts seems to settle in the affirmative. The credit of a witness may likewise be impeached by the general evidence of others as to his character. But in this case no evidence can be given of particular facts which militate against his general credit; as this would be in contravention of another rule, that collateral issues—questions of fact unconnected with the subject of dispute—shall not be raised during the course of a trial. Re-examination of a witness by the party who first examined him, must be directed to such new points only as have been raised by the cross-examination. If it is wished to put a question not connected with these points, the proper course is for the counsel to apply to the court to put the question for him.

Evidence, Documentary.—Written instruments, considered as evidence in a court of justice, have been divided into *public judicial* documents; *public non-judicial*; *private* documents; and *mixed*, which are partly public and partly private. The contents of the record of a court of justice are properly proved by inspection of the record itself; otherwise by *exemplification*, or by *sworn copy*. A copy of a record, under the seal of the Court of Chancery, or of one of the king's other courts, is an exemplification; as are also the records of some inferior tribunals. Office copies are evidence, wherever the law has intrusted a particular officer with the making of them. Sworn copies are copies proved on oath to have been examined with the original. All public documents, whether judicial or non-judicial, which cannot be removed, can be and usually are proved in this manner. But before it can be read, it must be proved that the original came out of the hands of the officer of the court, or from the proper place of deposit. A copy of a copy is in no case admissible.

Mixed documents are of a nature partly public and partly private; such as court-rolls of manors, and corporation books. Examined copies of these are evidence. The books of public companies—as, for instance, the East India Company—are evidence in questions between parties interested in them. Private writings are of two sorts: first, writings to which the person against whom they are offered was party or privy; secondly, writings of third persons. All documents of the first class are, in general, evidence against the party. And an admission under seal (as a deed or bond) is, in general, conclusive evidence against the obligor, or party binding himself; that is, he is *estopped*, or prevented, from offering to rebut it.

A discussion of the rules which govern the admissibility of written instruments not under seal as evidence would occupy far too wide a field for the present purpose. Oral evidence can in no case be received as an equivalent or substitute for an instrument, where a writing is required by law; or to give effect to such an instrument, if defective in any particular required by law; or to vary its terms, if it have been appointed, either by act of law or by compact of the parties, as a memorial of the transaction between them. This rule proceeds on the general principle already adverted to, that where the best evidence can be had, secondary testimony shall not be substituted for it. But oral evidence is admissible in various cases, to explain, to restrict, and to defeat instruments, on the ground of fraud or mistake.

Entries in writing, as well as declarations by third persons, are in general excluded. The cases in which they may be admitted are, either where they serve to explain and accompany material facts; or, in some cases, on a principle of necessity, where the party who made them is supposed to have had peculiar grounds of knowledge as to the fact in dispute. In the first category, as a common instance, we may cite declarations of a trader at the time of his quitting his place of business, which are commonly received in evidence on bankruptcy questions. The second may be instanced by entries of bailiffs or stewards, which are received where the payment of rent is disputed.

Proof of Written Documents.—This is effected either by witnesses, by admission of the adversary, or by enrollment; the latter mode of proof being confined to a few classes of documents by virtue of Acts of Parliament.

In the first and common mode of proof, the instrument must either be produced, or its absence must be accounted for by loss or destruction (and if either of these negative assertions, as they may be called, cannot be directly proved, evidence of diligent search will be received, and its contents may be proved by counterpart or secondary evidence); or it must be proved to be in possession of the adversary, and that notice was given him to produce it. In the case where the instrument itself is produced, it is either attested or not attested. If the former, the attesting witness must be called; or his absence must be accounted for, and his handwriting proved; or it must appear that the instrument is thirty years old, and has come out of proper custody, in which case its authenticity is presumed. Where a subscribing witness is called to prove a deed, proof of sealing and delivery is required from him: where there are several subscribing witnesses, one is sufficient. Where

there are no attesting witnesses to an instrument, the handwriting of the party binding himself is generally sufficient proof. On the proof of handwriting—a very difficult matter of evidence—we can only observe, that it is ordinarily proved by the testimony of a witness who has acquired a general knowledge of the party's hand, either by having seen him write (although but once), or by a correspondence with him, or other transactions. It is a general rule, that evidence by comparison of writings is not receivable; and this, although a skilled person (as a clerk from the Post-office) offer his opinion. *Public* documents, when the originals are not procurable, are commonly proved by examined copies, but their proof has been greatly facilitated by a series of modern statutes. For the law of evidence in Scotland, see especially the treatise of Dickson, 1855.

Evidence of Parties.—An important enactment was passed in the 14 & 15 Vict. c. 99, by virtue of which parties to suits, actions, or other proceedings in any court of justice are admitted witnesses. It provides that on the trial of any issue joined, or of any matter or question, or on any enquiry arising in any suit, action, or other proceeding in any court of justice, or before any person having by law, or the consent of parties, authority to hear, receive, and examine evidence, the parties thereto, and the persons in whose behalf any such suit, action, or other proceeding may be brought or defended, shall be competent and compellable to give evidence either vivâ voce or by deposition, according to the practice of the court, on behalf of either or any of the parties to the suit, action, or other proceeding. By this clause, in addition to the parties offering themselves to give evidence in their own behalf, their opponents can compel them to give evidence in the cause. Nothing in the Act is to compel persons charged with criminal offences to give evidence, nor is the Act to apply to proceedings in consequence of adultery. Further, the new law authorises the common law courts to compel an inspection of documents whenever equity would grant a discovery. Foreign and colonial acts, judgments, &c., are to be received in evidence, without proof of the seal or signature; so, also, are apothecaries' certificates. Documents are to be admitted in England or Ireland from either place, and the colonies, without proof of seal. Persons forging the seal or signature to be guilty of felony, and punished accordingly. This Act, which extends to all parts of the United Kingdom except Scotland, came into force on November 1, 1851.

Evocati (Lat. *called out*). In the ancient Roman army, soldiers were so named who, having received their missio, or discharge, were again called out for military service.

Evolute (Lat. evolutus, part. of evolvo, *I roll out*). If a perfectly flexible and inextensible string be conceived to be wrapped around any plane curve, then on unwrapping the same under tension, each point of the string will describe a curve of which the first curve is said to be the evolute. The curves described by the several points of the string, therefore, have the same evolute; they constitute a series of *parallel curves*, which are said to be *involutes* of the curve by whose evolution they are generated. The theory of evolutes was first examined by Huygens in his *Horologium Oscillatorium*, his object being to find the evolute of the common cycloid with a view of causing pendulums to vibrate in cycloidal arcs, and thus of securing the property of isochronism. [CYCLOID.] The evolute of a curve may obviously be regarded either as the envelope of the normals to a curve or as the locus of its centres of curvature. In most text-books the subject will be found treated from both points of view, and the methods of obtaining the equation of the evolute fully described. From the definition of a plane evolute it follows that it is a rectifiable curve, for the difference between the radii of curvature at any two points of a curve is obviously equal to the arc of the evolute joining the centres of curvature. In general, the evolute of a plane curve of the n^{th} order is of the order $3n\ (n-1)$ and class n^2; both these numbers, however, are subject to reduction in presence of certain singularities. (Salmon's *Higher Plane Curves.*) The class of the evolute gives, of course, the number of normals which can be let fall upon the curve from any point p in the plane. That this number is equal to n^2 has been very simply shown, by Steiner, in a most instructive paper on 'Algebraische Curven und Flächen' in Crelle's *Journal* (vol. xlix. 1855).

Besides the plane evolute hitherto considered, however, a plane curve has an infinite number of non-plane evolutes; in other words, there are innumerable curves in space, which on being unwrapped in the manner described will generate the given curve. This is best seen by considering the evolutes of non-plane curves in general. Let $m\,e$ be any one of the normals at a point m of such a curve, and let e be the point (on the polar line) in which it is intersected by the normal plane at the consecutive point m_1; then $e\,m_1$ will be the only consecutive normal which will intersect $e\,m$. Similarly $e\,m_1$ will be intersected, say in e_1, by a consecutive normal $e_1\,m_2$, and so on; in short, the whole series of intersecting normals which $e\,m$ determines will form a developable surface, the cuspidal edge e, e_1, e_2, &c. of which will obviously be an evolute of the curve m, m_1, m_2, &c. This evolute (e), however, is only one of an infinite number corresponding to all possible directions of the initial normal $e\,m$. The whole series, however, consists of geodesic curves, situated on the polar developable. They are geodesics because every osculating plane $e\,m\,m_1$ of the evolute (e), since it passes through the tangent $m\,m_1$ of the curve, passes also through its parallel, the normal at e of the polar developable.

From this it is evident that besides its plane evolute, every plane curve has an infinite series of *helical evolutes*, situated on the cylinder

perpendicular to the plane of the curve, and having the plane evolute for its base.

The evolutes of a spherical curve are all situated on the concentric cone which forms the polar surface. This cone cuts the sphere in the *spherical evolute* of the curve, which is the envelope of great circles normal to the curve, and must not be mistaken for one of the series of evolutes before considered. It is manifestly *not* a geodesic on the polar surface.

Spherical evolutes are merely particular cases of others, situated on any surface whatever, upon which the primitive curve is supposed to be traced. These may be defined as the envelopes of geodesic normals to the curve.

The tangent of the original curve is of course parallel to the normal of its evolute, which latter envelopes a *second evolute*, whose elements are parallel to those of the curve and perpendicular to the corresponding elements of the first evolute. Proceeding in the same manner, a series of evolutes are obtained the angles of contact of which are all equal at corresponding points. Euler has shown that the logarithmic spiral is the only curve whose evolutes are all similar to itself. Hypocycloids and epicycloids, which include the common cycloid as a particular case, are the only curves whose first evolutes are similar to themselves, and in an inverted position.

Evolution (Lat. evolutio, *an unfolding*). In Algebra and Arithmetic, the extraction of roots; in other words, the inverse operation to involution. The object of evolution, therefore, is to ascertain the quantity which multiplied by itself a stated number of times yields a given result. In a wider sense, evolution may be regarded as synonymous with the solution of a binomial equation, for it is obvious that the n^{th} root of any number a satisfies, or is a root of, the equation $x^n - a = 0$. This root is indicated by the symbol $\sqrt[n]{a}$ or $a^{\frac{1}{n}}$. The methods of extracting square and cube roots are given in all elementary works; and Horner's method of extracting any root whatever, or rather of solving, approximately, any numerical equation, now finds a place in every good algebraical text-book.

Evolution. In Physiology, that theory of generation in which the germ is held to preexist in the parent, and its parts to be unfolded and expanded, but not actually formed, by the procreative acts. The principal and most consistent supporters of this theory maintain that the first created individuals contained the germs of all future possible successors, successively included one within the other; and that generation is merely the act of unfolding, or an evolution of the germ: Swammerdam, Bonnet, Spallanzani, Haller, and Cuvier maintain this theory.

The theory of evolution is opposed to that of epigenesis generation, in which the germ is held to be actually formed as well as expanded by virtue of the procreative powers of the parent. Its chief supporters are Harvey, Caspar Fred. Wolff, Blumenbach, and the professors of the modern German physiological school.

Evolutions, Military. The movements by which troops change the order, position, and direction of their primary formation. All evolutions are performed according to a regulated system, which differs in its details in the armies of various nations; though in all of them simplicity, facility, and rapidity of movement are the points aimed at. It is probable that the precision and quickness of fire of the rifled arms now introduced will entail a great change in the existing systems of evolutions.

Evonymine. A crystalline, neutral, bitter principle found in *Euonymus europæus*.

Evovae. In Music, the vowels used with the ending notes of the ecclesiastical tones: the word is formed of the six vowels in the words *sæculorum amen*, which are subjoined to the notes in Antiphonaries, &c., to indicate that those are the ending notes.

Ex Cathedrâ. A Latin phrase; originally applied to decisions given by prelates, chiefly popes, from their cathedra or chair: i. e. in a solemn judicial manner. Hence applied to every decision pronounced by one in the exercise of his peculiar authority: a professor in his lecture room, a judge from the bench, &c.

Ex Officio (Lat. *by reason of office or duty*). In general language, every act done by an officer either in prosecution of the general duty of his office, or in executing some special duty imposed by it, is said to be done *ex officio*. But, in more strict phraseology, a proceeding *ex officio* is one taken by an officer of his own will, in execution of what he takes to be the duty of his office; as, where a justice of the peace demands and takes surety of his own discretion, without the request of the injured party. An ex officio information is an information at the suit of the king, filed by the Attorney-General, without applying to a court for leave. [Information.] Ex officio criminal informations are employed in cases of libel, sedition, &c., when officially prosecuted.

Ex Parte (Lat.). In Law, *of the one part*. A commission ex parte in chancery is that which is taken out and executed by one side or party alone, on the other party's neglecting or refusing to join.

Ex Post Facto (Low Lat. literally, *by something done afterwards*). A punishment which is inflicted in consequence of a law made with a view to a particular offence already committed is said to be inflicted ex post facto; and the phrase *an ex post facto law* is popularly applied to all laws enacted with a retrospective effect and with an intention to produce that effect, which is justly regarded as tyrannical. That species of laws which the Romans termed *privilegia*, i. e. laws passed in order to impose restrictions on individual citizens, were frequently ex post facto. The English practice of a *bill of pains and penalties* is a species of ex post facto legislation, and was much animadverted on in the debates which took place on the occasion of its adoption against Queen Caroline in 1820.

Exacerbation (Lat. exacerbatio). An increase in the violence of symptoms of disease; as of pain, or especially of fever.

Exaeresis (Gr. ἐξαίρεσις, *a taking out*). One of the divisions of Surgery adopted by old writers, and confined to operations concerned in the removal of parts of the body.

Exaltados. In Spanish History, the name of the party attached to what has been vulgarly termed the *liberal* system of politics, corresponding to the *extrême gauche* of the French, or Whig-radicals among ourselves.

Exaltation of the Cross. A feast of the Romish church, celebrated on September 14, to commemorate the restoration to Calvary, in 628, of the Cross which had been carried off fourteen years before by the Persian king Chosroes.

Examiners. In Law, officers of the Court of Chancery appointed to examine witnesses on either side. The evidence taken by them follows the rules for evidence given in the common law courts.

Exangia (Gr. ἐξ, and ἀγγεῖον, *a vessel*). A term applied by some medical writers to diseases in which large blood-vessels are broken or perforated, or enlarged, without any external opening: it includes *aneurism*, *varix*, and *cyanea*.

Exanthalose (Gr. ἐξανθέω, *I effloresce*). A name given by Beudant to native *sulphate of soda*, occurring as an *efflorescence* on certain lavas, and elsewhere.

Exanthematous (Gr. ἐξανθέω, *to effloresce* or *break out on the surface*). A term which includes in its meaning all eruptive diseases accompanied by fever.

Exarch (Gr. ἔξαρχος). The title of the viceroys of the Byzantine emperors in the provinces of Italy and Africa after they had been reconquered by Justinian. The exarch of the former province fixed the seat of his government at Ravenna. They were also styled *patricians*. The exarch of a diocese was, at first, the same as the primate. The term was also applied in the Eastern church to the general or superior over several monasteries; and it further denotes the deputy of the patriarch, whose duty it is to visit the churches and clergy in the provinces allotted to him.

Exauctorati (Lat.). In Roman military practice, soldiers were so called who, having served for sixteen years, remained under a *vexillum* or standard of their own for four years longer, when they received a full discharge. After the fall of the republic, the word *exauctorare* came to be used chiefly in the sense of cashiering for misconduct. [Evocati.]

Exauguration (Lat. exauguratio). In Roman Antiquities, the act of changing a sacred thing into a profane one. It was performed, as the name implies, by the augurs, who first consulted the gods to know whether they gave their consent. This process was necessary in the case of consecrated persons as well as of sacred buildings; priests could not without this ceremony give up their functions, or (if bound to celibacy) enter into matrimony.

Excaecaria (Lat. excæco, *to make blind*). The *E. Agallochum*, an Eastern species of this genus of *Euphorbiaceæ*, has been supposed to be the source of Aloes or Eagle wood, which is now, however, known to be produced by *Aquilaria Agallochum*. It is a small tree with acrid milky juice, which if it gets into the eyes causes blindness. The wood is sometimes used as firewood, but the smoke from it is said to occasion intolerable pain in the eyes. The greater part of the species are West Indian or South American.

Excambion (Ital. cambio, *exchange*). In Scotch law, the name given to the contract by which one piece of land is exchanged for another.

Excellency. A title of honour in various European states. It was borne, successively, by the Lombard kings; by some emperors of the West; by various minor Italian potentates; and it is now appropriated to persons in the actual execution of certain official services; ministers, some court dignitaries, and ambassadors, but not chargés d'affaires. Governors of English colonies are styled *excellency*.

Excentric (Lat. ex, *out*, and centrum, *centre*). In the ancient Astronomy, the deferent circle in the circumference of which the centre of the epicycle of a planet is carried forward in its orbit round the earth. It was *excentric* in respect of the earth; that is, though the orbit of a planet was a circle described about the earth, the earth was not placed at the centre of that circle. In modern Astronomy, the excentric is the circle which circumscribes the elliptic orbit of a planet. [Anomaly.]

Excentric. In Machinery, a wheel in which the axis is removed from the centre of the figure, or of which the periphery is not circular. Excentrics are used for converting circular motion into alternating, rectilinear, or intermitting motion, and are usually driven by bands or straps.

Excentric Angle. In Geometry, the same as the excentric anomaly in Astronomy. [Anomaly.] The introduction of this angle is frequently of service in the treatment of geometrical questions concerning the ellipse. [Ellipse.]

Excentricity. In Astronomy, the distance of the foci from the centre of the elliptic orbit of a planet or satellite, the semi axis major being regarded as unity; it may also be defined as the ratio of the distance between the focus and centre to the semi axis major. Thus, if a and b denote respectively the semi axes major and minor, and e the excentricity, we have $a e = \sqrt{a^2 - b^2}$. *Excentricity* is thus to be carefully distinguished from *ellipticity*, which denotes the ratio of the difference of the two axes to the greater. [Planet.]

Exception (Lat. exceptio). In Law, a stop or stay to an action. In common law proceedings, a denial of a matter alleged in bar to an action. In chancery, what is alleged against the sufficiency of an answer.

Excess, Spherical. [Spherical Excess.]

Exchange (Fr. échange). In Political Economy, the mutual interpretation of utilities when measured by some common standard of price. The equation of value in commodities. The satisfaction of supply and demand in such objects as possess an economical value.

Many objects may possess a great value to mankind, and yet not be susceptible of any economical estimate. Some of these are natural, as the qualities or forces of objects. There is infinite value in the physical properties of iron, in the power of wind as a motive force, and in the qualities of water as supplying the means for a road on which comparatively small friction is experienced. But these powers being universal, have no economical value. Although great importance is to be assigned to those characteristics of gold and silver which make them so apt to supply the needs of a currency, these peculiarities, though of high economical significance, have no economical value. The same reasoning applies to the moral qualities of individuals and communities. These qualities may be, and commonly are, the foundation of material progress and comparative wealth; but as they are not commensurable with any other object, they cannot be estimated by any standard of price, and they consequently have no value in *exchange*, however important may be their value in *use*. On the other hand, many products of labour may have no value in use, may even tend to deteriorate the character and capacity of those who produce and purchase them, but have an economical value because they can be measured by prices, and be exchanged against other commodities. It may be very desirable that their production should be diminished, or should wholly cease, and the labour devoted to their acquisition be turned to some other object or objects; but they are all objects of economical value, because they may be the material of exchange, and thus have a value in exchange.

A sale is an incomplete exchange, or, as J. B. Say has expressed it, is half an exchange. When a seller receives money in satisfaction of something which he has resigned to the use of another, he does not take the money because he can devote it, by any natural qualities which it possesses, to any personal service of his own (unless he melts it in order to manufacture plate from it, or to use it otherwise in the arts); but because it possesses certain conventional qualities, those namely which belong to it as a universal factor, in procuring whatever he may need hereafter, at little or no depreciation in its intrinsic or cost value. Gold and silver are produced in nearly equal quantities by nearly equal labour; and therefore their values, as measured by themselves, have the general characteristic of invariability in price. This fundamental fact in the nature of money is recognised by Aristotle, who says that 'money is a pledge of the power of future exchange,' and that 'while it varies in its own value, it does so less than any other commodity.' (*Ethic. Nic.* 5. 5. 11 & 14.)

The exchange is completed when the money received for some commodity is again resigned, in compensation for a service or utility rendered either by the first purchaser, or far more commonly by some other person. In the division of occupations, the article in which one person deals may require a large market; that in which another trades, a small market; and thus it would not be possible for trade to be limited to the mutual exchanges of two persons. A town, for instance, the demands of which would suffice to maintain only one brewer, may be able to support ten grocers. By the circulation, however, of money, exchanges may be indirectly effected between all the persons resident in the town, and similarly between persons residing in different towns, and ultimately between persons residing and carrying on commerce in different countries. As a man's expenditure is necessarily regulated by his income, so a nation's trade is enlarged and diminished by the amount of its exports; and just as it is not necessary that a person B should exchange with one other person only, but may buy of A far more than he sells to him, so the excess of importation from one country must be ultimately balanced by an excess of exportation to another; just as the whole purchases of B must be regulated by his whole receipts.

So closely is the doctrine of exchange connected with economical values, that some economists, De Quincey for instance, have urged that exchange forms the actual centre of the system, and that the truer and more significant term for the science should be *catallactics*, or the science of exchanges. No doubt, from a purely analytical point of view, such a theory could be urged with great force, and it must be admitted that the method would give that precision to economical inferences in which they are as yet very deficient.

But on the other hand, what may be called the synthetical theory of the science commends itself more—proper precautions being taken for exactness—both on the ground of its didactic value, and from its breadth and fulness. Wealth is a state as well as a quantity; and in the former estimate, it will be impossible to exclude the consideration of those indirect forces which really contribute to the state of wealth, though it would not be possible, or at least easy, to interpret their position in discussing the process of production, or in resolving the bare act of exchange into its elements. To consider the act of exchange only in relation to wealth, would be, to use a close analogy, similar to the developement of a theory of logic which should take account of the syllogism only, and should not only omit all mention of the inductive process, but should decline to consider the qualities of concepts; the relation of language to thought, and the properties of propositions; to confine economical anatomy to the skeleton, and ignore the rest of the organisation.

Society, from the point of view taken by economists, is an organisation in which mutual needs are met by mutual benefits; a gain in

the act of exchange occurring to both parties who enter into mutual contracts. This fact that there is a gain to both persons is fundamental in all trade; and applies equally to home and foreign trade, though so great a man as Bacon was led to believe that the profit of English trade was a loss to the trade of foreigners, and though so many attempts have been made to further supposed interests by legislative and fiscal expedients. Hence, as there can be no means by which this mutual gain can be interpreted except from the wishes of the contracting parties, and as any interference with the will at once weakens its force, and diminishes its capacity for determining what constitutes its best interests, freedom is as essential in exchange as it is in morals. In Economics, the interference with the judgment of the parties to an exchange is in ordinary cases sure to make economical action cramped, distorted, or paralysed.

Where slavery prevails, all the benefit is on one side; for no person, unless inveterately stupid, would continue to be a loser in the contract, except by force. In such a social state, one of the parties in production, occupying a position from which there is no escape, has no motive for improving his capacity, since all improvements in production, and all substitutions for labour, are primarily due to the disposition on the part of labour to shorten its own exertions by the intelligence which appropriates and directs other supplementary forces. No one will work well who has no possible means for serving himself, nor will anyone work intelligently who is absolutely debarred from reaping any of the fruits of his own intelligence. Hence, where slavery prevails, that state which economists call *stationary* is soon reached; in other words, the accumulation of wealth ceases; whereas when exchange is free, those motives are always present by which greater results are obtained from equal areas and equal capitals at less cost, and the state of economical progress is assured.

The moral and material instincts of mankind have combined to abolish slavery from the greater part of the civilised world. But other arrangements, only less hostile to the accumulation of wealth, and its equitable, that is its natural, distribution, still prevail in many countries, in the regulated trades and protective traffic of different communities. Protective systems have been adopted on very different grounds. Sometimes they are defended from their supposed benefit in furthering such industrial occupations as seem to have considerable political or social advantages implied in their adoption or prosecution. Sometimes they have been accorded as a counterpoise to supposed peculiar burdens levied on certain classes of the community. Occasionally they have been allowed in consideration of certain real services supplied by particular corporations. Some of these protective acts exist in our own country; many of them are clung to in other communities, and always mischievously. [PROTECTION.]

Though, however, on general grounds, the freedom of individuals in acts of exchange must be vindicated, yet there are certain circumstances affecting certain persons, permanently or temporarily, in which a subsidiary control must be exercised. No one doubts, for instance, that there is a period of incapacity during which persons, by reason of their age or condition, are unable to cope with those who are more capable of gaining the advantage of a commercial transaction. The maxim *Caveat emptor* does not apply to a child or a lunatic, any more than the ordinary rules of moral obligations do, and the ordinary responsibilities of moral actions. But the exercise of authority in cases where the individual is only temporarily incapable of appreciating the terms of a contract is always relative to the temporary incapacity only. Authority is never a substitute for action, but can only be an aid to it.

Omitting, then, those cases in which non-age or mental weakness require that the general right of action should be delegated, those invasions only of *laissez faire* can be defended in which a monopoly price can be exacted from one of the parties, or in which the sagacity of an administration recognises that certain prospective advantages may occur to society by a course of action the value of which is not understood at present, but will certainly be understood hereafter.

The most notable among these instances are: First, the right of government to regulate certain charges for necessaries, as for example the transit of passengers and goods by railways; the power of charge being in these cases completely at the discretion of the managers of the railway, and wholly removed from a true competition; for it is clear that at present no method of carriage can equal a railway in quickness and precision, and nothing can prevent, even in case two railways supply transit from the same place, a combination between the directors of both to raise rates, in accordance with the vulgar instinct that high prices mean high profits. In such a case, it is not only a privilege, but a duty of government to regulate the charge at which the service is rendered. Secondly, it is equally regular for government to interfere in order to secure the advantages of education, in the best sense of the word, to all classes of the community. Uninstructed people are so little informed about the benefits which ensue to themselves by the fact that they are properly educated, and even parents are so little careful of what is their real duty to their children, that if one waited till the time at which they might become alive to its necessity, the best opportunities would be lost. It has been proved repeatedly that the comparative progress of nations depends largely on the extent to which the means of a sound national education are supplied; and it is known in practice that the spread of a good system of education is the best means for eliminating social vices and miseries, for inculcating morality, and for securing the largest national benefits. The same reasoning, on the other

hand, applies to such endowments or supports to learning and religious teaching as are needed in order to secure the recipients the leisure or capacity for the social advantages which they supply. As long as men are not alive to the good which is derived from the highest education, it is mere folly to repudiate the assistance of such means as sustain the most valuable of social services, before the value itself is recognised and estimated. When the recognition is complete, the aid may be abandoned.

Exchange, Bill of. An instrument which contains an order of payment on a debtor at a distance from his creditor, and which may thus become a means for liquidating transactions by transference to some third party, without the actual conveyance of specie.

It is clear, if trade be carried on between two towns, or two countries, and debts are contracted by reason of this trade, that great loss will ensue, from the necessity of perpetually transmitting money to and from each of these localities, and that expedients will be adopted to shorten the labour and expense of the transaction. In other words, accounts or debts may be written off against each other by the interchange of written instruments declaring the quantity of debt, and issued in confidence that the obligations created and acknowledged will be met when the document is presented for payment. This commercial confidence is quite distinct from public credit, is protected by its vital importance to the mercantile world, and must be guarded by strict regulations and even penalties upon breach of faith.

So important is the economy of this machinery, that expedients virtually equivalent to the creation of bills of exchange have been adopted in all such civilised communities as encourage or require any considerable trade. Tallies presentable at the various banks in the chief cities were familiar to the Greeks in the classical age, and orders on bankers in distant places were frequently given to merchants and travellers in order to avoid the cost and risks of carrying specie. The speech of Demosthenes against Callippus gives full information as to the manner in which bankers' books and securities were kept in Athens, as well as of their system of exchanges.

Similarly, the Romans invented mercantile instruments, under the name of *literæ cambiales*, which answered all the purposes of bills of exchange. Even were we not possessed of evidence as to the existence of the practice, we might be sure that the expedient would be adopted in the perpetual need for the transfer of tribute to Rome, and the payment of troops in the provinces.

It is said that either the Caursini or the Lombard merchants in the thirteenth century were the first to introduce the system into the mercantile arrangements of modern Europe; and it has been held that the notorious transmission of the profits of English benefices to foreign ecclesiastics, appointed by papal provisions, first called these instruments into existence in England. In all likelihood, however, the custom had prevailed long before, and the attention awakened by the magnitude of the transactions at the period referred to, has been mistaken for the commencement of the practice. This country had from very remote times a considerable export and import trade with the Continent, the exports consisting of farm produce, especially wool; and the imports comprising the linens of Flanders, the silks of Italy, and the spices carried by the Italian merchants from the East by the two overland routes to Trebizond and Antioch, and the sea route through Aden, Cous, and Cairo. This trade in exports and imports would have naturally called bills of exchange into existence.

Among cities or countries having any considerable intercourse together, the debts mutually due by each other tend to an equality. There are at all times, for example, a considerable number of persons in London indebted to Hamburg; but, speaking generally, there are about an equal number of persons in London to whom Hamburg is indebted; and hence, when A of London has a payment to make to B of Hamburg, he does not remit an equivalent sum of money to the latter, but he goes into the market and buys a bill upon Hamburg for an equal amount—that is, he buys an order from C of London, addressed to his debtor D of Hamburg, directing him to pay the amount to A or his order. A having endorsed this bill, or order, sends it to B, who receives payment from his neighbour D. The convenience of all parties is consulted by a transaction of this sort. The debts due by A to B, and by D to C, are extinguished without the intervention of any money. A of London pays C of ditto, and D of Hamburg pays B of ditto. The debtor in one place is substituted for the debtor in another; and a postage or two, with the stamp for the bill, form the whole expenses.

In mercantile phraseology, the person who draws a bill is termed the *drawer*; the person in whose favour it is drawn, the *remitter*; the person on whom it is drawn, the *drawee*, and after he has accepted, the *acceptor*. Those persons into whose hands the bill may have passed previously to its being paid are, from their writing their names on the back, termed *endorsers*; and the person in whose possession the bill is at any given period is termed the *holder* or possessor.

The negotiation of inland bills of exchange, or of those drawn in one part of the United Kingdom on another, is almost wholly in the hands of bankers. Many of the banks established in different parts of the country have a direct intercourse with each other, and all of them have correspondents in London. Hence an individual residing in any part of the country who may wish to make a payment in any other part, however distant, may effect his object by applying to the nearest bank. Thus, suppose A of Penzance has a payment to make to B of Inverness. To send the money by post would be hazardous; and if there were fractional parts

of a pound in the sum, it would hardly be practicable to make use of the post. How, then, will A manage? He will pay the sum to a banker in Penzance, and his creditor in Inverness will receive it from a banker there. The transaction is very simple. The Penzance banker instructs his correspondent in London to pay to the London correspondent of a banker in Inverness the sum in question, on account of B; and the Inverness banker being advised in course of post of what has been done, hands over the money to B. The whole charges are limited to a trifling commission and twopence for postage, so that the affair is transacted in the cheapest as well as in the most commodious possible manner. Such a system is not only the most advantageous to the parties, but also to the public, who are thus enabled to dispense with as much as possible of the dear materials, gold and silver, and to make the fullest use of that which remains in their hands and forms the substratum of all these transactions.

Generally, bills of exchange are not payable at sight, but at a future date specified in the document; this date being ordinarily three months after acceptance. But there is nothing to prevent a bill being drawn so as to be payable at sight, that is on presentment, the postponement of the payment being relative to another commercial practice, that of procuring the funds, hereafter to be secured from the sale of commodities, by anticipation, and by paying a certain sum, called *discount*, in consideration of the advances made.

It has been stated that a bill of exchange may be transferred to a multiplicity of persons, each of whom on transferring endorses his name on the back of the instrument. When this endorsement is made payable to the *order of the transferree*, it is called *special*; when only the signature of the *transferrer* is given, it is called *general*. Thus if the person holding a bill transfers it to the order of A B, the transference is of the former kind; if he simply writes his name across it, of the latter. A special order, as it creates a particular interest in the bill, which cannot without forgery be appropriated by another, is the safer method.

Bills are often drawn in sets, the first being accepted, and all being discharged on the payment of that accepted. The first of a set is generally sent without endorsement, in order that it may be accepted, and kept until demanded by the holder of one of the other bills. When the accepted first bill and endorsed second are wafered together, they become one bill in law.

Each endorser is liable for the payment of a bill in case the drawee or acceptor does not pay it; the names of endorsers forming accumulated security. Hence it may happen, that the credit of one endorser being higher or of more significance than that of others, a bill may increase in value, or, what is in effect the same thing, be negotiable at a lower rate of discount by the existence of the particular endorsement. It is said that this fact has been made the means by which great profits have been secured by bill-brokers where commercial character is high.

The amount of foreign bills is generally expressed in the currency of the country in which the bill is to be paid; thus a bill drawn in London on a house in France would be expressed in francs and centimes. Sometimes, however, it is expressed in the currency of the country in which the drawer trades. Thus a bill drawn on France, but negotiated in London, is frequently expressed in sterling. In this case it is the practice to pay the amount at the rate of exchange which existed on the day at which the bill was endorsed or negotiated.

When the law of the place requires it, bills must be drawn upon stamps. The days of grace, that is the period after date at which the bill must be presented, are in England three. If, however, the third day be a Sunday, Christmas-day, or Good Friday, the bill is reckoned due the day before.

Bills of exchange, when based on what are called *real transactions*, are a means by which the capital possessed by lenders is rendered available for the activity and capacity of borrowers; that is, they tend to utilise and circulate capital which would otherwise be dormant. Such are the great mass of bills negotiated in the course of trade. A man sells goods, and accepts in place of present payment a bill from the purchaser, which bill is discounted in the usual form, the amount being met at the date specified, under certain commercial and legal penalties, by the acceptor, who provides for it by the resale of the goods purchased.

But of course it is possible, if precautions can be taken to prevent detection, for two persons assuming the appearance of drawer and acceptor to create and negotiate bills which are based upon no real transaction at all, and therefore to be deficient in the requisite stability of a sale and transfer of goods. Such bills are called *accommodation* or *fictitious bills*, and the circulation of such paper is an injury to legitimate trade, a material for rash and dishonest speculation, and a mischief to the public at large. It is an injury to trade, because such a competition for accommodation in the money market, especially when it is likely to be large in its amount, raises the rate of discount, and so diminishes the profits of the honest and bonâ fide trader; it leads to speculation of the worst kind, because the disposition to avow in a commercial instrument that value has been received, in other words that a real transaction lies at the bottom of the bill, when no such transaction has taken place, and no such value has been received, implies à fortiori that the creation of such documents has for its end some venture which would not be recognised on its own merits; and it is a public mischief, because, as all purchases affect prices, and as only those purchases affect prices legitimately which are founded on the demand of consumers and the amount of produce available for their use, such speculative transactions as are likely to give occasion

to these forms of paper credit raise prices beyond their true or market rate, and operate disadvantageously on the public. Many of the worst cases of commercial dishonesty and fraudulent bankruptcy are traceable to the practice of drawing and accepting accommodation bills.

Exchange, Par of. If the coins of any country, estimated at their mintage valuations, are compared with the coins of another country, estimated also under similar conditions, the proportion deduced from such a comparison is called a *par of exchange*. Thus, for instance, the French gold coin is only $\frac{9}{10}$ths fine, while English gold is $\frac{917}{1000}$ths fine. Again, there is a retenue or charge for coining gold and silver in France amounting to six francs on the kilogramme in gold, and two francs on the kilogramme in silver. Hence, while the kilogramme of coined gold is valued at 3,100 francs, and that of silver at 200 francs, the prices paid by the Mint are 3,094 and 198 francs respectively. Under such circumstances the settlement of the par of exchange must take into account these variations and deductions.

On the other hand, the par of exchange, in the estimate of silver coins in this country, must take into account the fact that silver is purposely over-valued by the Mint regulations. Were French coins estimated in the British silver currency, without such calculations, the par in silver would be 1*l.* = 23 francs 24 centimes; while the par in gold would be (without any agio) 1*l.* = 25 francs 22 centimes.

Except, therefore, in estimating the value of coins actually imported from foreign countries, the par of exchange is of no practical significance; and as gold is not generally the standard of value in other countries, but bears an agio or premium varying with the circumstances of the case, the valuation of foreign coin becomes in effect a valuation of bullion.

Exchange, Rate of. By this term is meant the price of the money of one country reckoned in the money of another country. In one country the rate is fixed, in the other variable. In exchanges between London and Paris, the rate is the value received for the pound sterling. In exchanges between London and Madrid, the value given is a variable amount in pence for the hard dollar. Hence in the rate between London and Paris, sterling is fixed; in the rate between London and Madrid, sterling is variable: the negotiator being said to give in the latter, and to receive in the former case.

The course of exchange from London, in receiving, is:—

Amsterdam .	12 florins 8 stivers.	*for*	£1
Hamburg . .	13 marks 12 schillings	„	1
Paris . . .	25 francs 50 cents	„	1
Frankfort . .	121 Zollverein florins	„	10
Vienna . . .	10 florins 2 kreutzers	„	1
Genoa . . .	25 lire 35 centesimi	„	1
Berlin . . .	6 dollars 25 silber groschen .	„	1
Leghorn . .	30 lire Toscane 50 centesimi .	„	1

In giving:—

Lisbon	$53\frac{1}{2}$	pence .	*for*	1 milreis.
Madrid	$50\frac{1}{2}$	„ .	„	1 hard dollar.
Gibraltar . . .	$48\frac{1}{2}$	„ .	„	1 hard dollar.
Naples	$39\frac{5}{8}$	pence .	*for*	1 ducat.
Venice	47	„ .	„	6 lire Austriache.
St. Petersburg .	$38\frac{1}{2}$	„ .	„	1 silver ruble.
Rio Janeiro . .	30	„ .	„	1 milreis.
New York . . .	$47\frac{1}{2}$	„ .	„	1 dollar.
Calcutta . . .	23	„ .	„	1 rupee.

See, for full information on the practical system of exchanges, Tate's *Modern Cambist*, from which work the foregoing rates are taken.

The rates of exchange as given above indicate what will be the proportion between the currency of any two countries when no exceptional circumstances arise to disturb the equilibrium of money values. In effect, however, rates are constantly oscillating in slight degrees above or below the precise proportions given. These oscillations are due partly to circumstances affecting the price of bullion in different countries, partly to the necessity for transmitting specie in liquidation of obligations from one country to another.

Thus when in any country two kinds of currency, gold and convertible paper, are simultaneously in circulation, the rate of exchange between this and another country will oscillate within narrow limits on either side of the proportions given above, a slight premium levied on the paying country being required by the broker who undertakes the business of liquidating obligations on commission; this premium being subject, by the competition of the market, to the fullest effect of all the influences which tend to increase or diminish the rate. When, however, the circulation consists of inconvertible paper, the value of this currency will not only be liable to the disturbances consequent upon the varying market value of the paper, but also to the contingency of variations at the time when the paper is due. Thus the rate of gold in the United States and the rate of exchange with England differ considerably, the value of United States' currency being much lower according to the latter than according to the former estimate. In reality, of course, exchanges between country and country are effected in that which all nations will receive, the precious metals, though for convenience' sake they are expressed in the currency of the country in which the bill is ordered to be paid.

The business of negotiating foreign bills of exchange is chiefly in the hands of brokers, who know by means of certain simple calculations what is the rate at which they can consent to undertake the function in question, and the best means by which they can effect the exchange with the greatest profit to themselves, and who are of course fully alive to all circumstances which increase or diminish the competition for the service they render. For when a person has to remit a sum of money to another country, he does not seek out a person who has to receive a sum from that country, but is furnished by a broker with a bill, which has very likely been purchased by the broker the same day from some other customer. If the amount of business done between two countries is exactly equal, the liquidation of all transactions will be effected by the mere transmission of bills. If,

however, it be more in one case than the other, the rate of payment made to the broker rises, in order that he may cover the charge of carriage and insurance in the transmission of specie, or the larger labour of a circuitous liquidation. In this case bills on the foreign country are at a premium, because more are wanted than are given in return. When, however, more are offered to brokers than are sufficient to cover those which they have to grant, bills are at a discount, and the price of the security as estimated by the premium charged on commission will fall. When, therefore, bills are at a premium in one country, they are at a discount in another, and vice versâ.

It does not indeed always follow, because there exists a necessity for paying a balance of specie to one country, that specie will necessarily be exported for that purpose. The obligation may be temporary, and speedily covered by the creation of a debt per contra. The existence of a necessity to export specie is equivalent to a stimulus to exportation generally, and a discouragement on importation. Hence where the disagreement between the value of commodities bought and sold in any two countries is casual or temporary, the amount in excess due to one country is liquidated by bills created to meet the quantity of commodities exported in order to meet the excess in question. But a different state of things ensues when the cause inducing what is called an unfavourable state of the exchanges is permanent, or when there is an expectation that great and immediate money payments must be made. We shall advert below briefly to the state of things which ensues from these and similar phenomena under the head of EXCHANGES, FOREIGN.

For the sake of convenience, we have treated exchanges hitherto solely from a simple or hypothetical case; that, namely, which considers all exchanges as carried on between two countries only. But it will be remembered that the whole exports of a country, in whatever direction they go, pay for its whole imports, and that therefore exchanges and their rates do not depend on the amount of goods transmitted to countries separately, but on all taken together. England may owe a balance to France, but hold debts due to herself on Hamburg; and in this case, the debt due to France may be met by bills drawn on Hamburg. This method of meeting obligations is called the *arbitration of exchange.*

Exchanges, Foreign. The process of liquidating obligations created between different communities or governments does not differ in any of its principles from those which regulate the traffic in bills of exchange between different towns within the same community; but it is affected by particular or special circumstances, to such an extent as seemingly to put the trade in foreign bills into a totally different category from those of home circulation. When it is remembered that the trade in money, or securities representing the worth of money, by expressing quantities of money, is liable in the fullest sense to competition, to the effect of supply and demand, and to other cognate economical forces, it will be clear that circumstances which tend to produce oscillations in market rates will apply with the greatest significance to the trade in foreign bills, because greater latitude is given in such securities for the influence of these exceptional events.

When all the accounts of a country with any other country are balanced evenly, so that values on both sides exactly correspond, they will be written off against each other, and the exchange will be at par. Such a state of things, however, is only hypothetically conceivable, for no accounts between country and country represent an exact equality. In the case of inequality, as has been said above, the rate is arbitrated by the interposition of bills drawn on other countries where a similar inequality prevails, due to the fact that in these the ratio is reversed; that is, that a greater indebtedness existing, a larger right to payment exists. Here, however, the first element of variation arises.

The standard of payment in this country is gold; in almost every other country it is silver. In every country but our own where gold is current, silver is similarly current; that is, where gold is a legal tender, silver is also. It now becomes necessary not only to consider what is the rate at which the liquidation can be effected, consequent on the greater or less amount of bills for sale, but what is the proportion which one form of currency bears temporarily to another; in other words, the foreign exchanges are virtually bullion transactions, and the rate of exchange being controlled by the *contingent necessity of exporting specie in liquidation of claims*, the question as to what means must be adopted for securing the presence of that metal in which payment must be made will materially affect the rate of exchange.

Again, the exigencies of a particular year or of a particular demand may cause that the balance of payments may be continuously adverse to any country. A bad harvest may necessitate a large purchase of corn; a rise in the price of some raw material of great importance may so disturb the market as to necessitate large purchases on account of manufactures; the exportation of large quantities of capital for foreign investment may necessitate a large efflux of specie, or, what is practically the same thing, may compel exports at lower prices; an engagement in the production of an article of great value, but of deferred supply, as of some particular crop, may compel the negotiation of securities with a view to bridging over the interval between production and sale; a panic felt at the approach of a commercial crisis may necessitate the holding of large quantities of the metallic currency in order to secure commercial safety; and these among other causes bring about that traffic in bills of exchange which implies what is called an unfavourable state of the foreign exchanges. As the rate at which bills are negotiated may under these circumstances approximate to the cost of

transmitting specie, but can never exceed it, the occurrence of any among these economical phenomena may lead to exportation of specie, continued till the cause which gives rise to it is met by a diminution of the cost of transmitting specie to the cost of transmitting bills. Anything, in short, which induces that state in which the charges of a community exceed its ordinary productive powers, will lead to an adverse exchange, and therefore diminish the metallic currency, either by liberating a portion of what has been hoarded or by drawing upon the reserves of banks.

The expression *adverse* or *unfavourable exchange* is a tradition of the time in which it was held to be an economical axiom, that the governments of such countries as are not producers of the precious metals should do all in their power to facilitate the importation, and retard or hinder the exportation, of gold and silver. At the present time, it is known that gold and silver are commodities, produced, exported, imported, or retained for special ends and for these alone, and that in ordinary times so much of them is retained for the use of a community as is absolutely needful, and no more. Hence in such communities as our own, in which money is made to set in motion as much commercial machinery as is possible, the quantity retained always tends to a minimum amount.

When, therefore, any events in foreign commerce occur which render necessary the payment of specie beyond the balance of goods, even though the diminution in the circulating medium be small, the effect is instantly apparent on the money market. The metallic currency possessed by a country is the power by which all commercial processes are set in motion, in the same way as the various machines in a great factory are impelled by the motion of a single rod in a steam engine, the force of the engine being, in order to avoid waste of power, exactly proportioned to the work it has to do. If, however, any portion of this force be subtracted or diverted, what remains is no longer adequate to perform the functions previously carried out; so if the currency sufficient to sustain the ordinary transactions of a community is suddenly diminished, some part of the gear must be slackened, or some of the machinery must lie idle, or some expedient adopted in order to recover what has been lost. Thus it follows that the amount of accommodation in discounts must be contracted by raising the rate at which the aid is given, and attempts must be made to right matters by an excess of exportation and a diminution of importation, that is by a process the reverse of that by which the drain of bullion was caused.

The effect of an adverse state of the exchanges is therefore twofold. It abstracts a commodity never kept, if possible, in excess, and so diminishes a necessary supply, while it also renders the means which on hypothesis underlie all commercial transactions and express all commercial obligations, more difficult to get at, because more the subject of competition. Part of these results are natural, and derived from purely economical considerations; part are adventitious, and the result of the legislature of 1844, in the Bank Charter Act of Sir Robert Peel. The first of these results has its natural corrective in the readiness with which foreign capital is imported into a country in which a high rate prevails, by the inducement afforded from a high rate of interest; but the latter, by reason of the rigid and artificial character of the Bank restrictions, is less susceptible of remedy, and has been met on two occasions by the suspension of the conditions which form the basis of the Act itself, that is by granting the Bank permission to issue in excess of the amount allowed by the Act, and by giving a government guarantee of a bill of indemnity.

The subject of foreign exchanges has been lately discussed with great exactness and clearness by Mr. Göschen, to whose able scheme on the subject the reader may be referred.

Exchequer Bills. These are virtually bills of exchange issued by government in anticipation of revenue, and on the confidence of the annual financial income. They bear interest at a fixed rate, this rate being computed at the time of their issue, at a sum proportioned to the current market rate, the fluctuations in the value of these securities depending on the proportion which such a rate bears to successive changes in the market price of money: when this is high, the security being at a discount; when low, at a premium.

The origin of exchequer bills is to be referred to the earliest period of systematic finance of England; to the consequences, namely, of the Revolution of 1688. At that time, the success of the political changes effected in Great Britain was closely identified with the maintenance of public credit, although (as might be expected, at a crisis when financial expedients and the machinery of commerce were experimental and dubious) confidence was capricious and feeble. Banking on any systematic and large scale was in its infancy, and its principles were imperfectly recognised. The currency was in a most degraded condition, the nominal value of silver coin being nearly double that of its actual weight, while the nation was staggered with the magnitude and weight of its expenditure, as well as bewildered by the apparent insecurity of its new institutions, and the notorious disaffection of a large portion of the aristocracy and landowners to the new establishment.

The first issue of exchequer bills, in 1696, was suggested by the financial genius of Mr. Montague, and was in aid not so much of the revenue as of private credit, by supplying a substitute for the currency, which at that time had reached its lowest point of degradation and was being reformed. The effect of the issue was most salutary. The bills were eagerly received as currency, having been issued in very low sums, and contributed more to put trade on a sound footing than anything else.

Since that year, exchequer bills have been annually issued, and now form a regular portion of the annual supply, and of an annual vote, the amount and the rate being yearly determined by Act of Parliament.

Exchequer bills are a convenient form of investment in banking and other analogous establishments. There is a security that the amount designated in them will be repaid in full with interest, low indeed, but determined by the market, and commensurate with the conveniences of this form of investment. They are receivable in payment of taxes, and therefore, pro tanto at least, are an annual addition to the currency. The interest paid on exchequer bills in the years 1860–1, 1861–2, 1862–3 respectively was 300,087*l.*, 478,400*l.*, 371,917*l.*, and on exchequer bonds 100,000*l.*, 122,500*l.*, 123,700*l.*

Exchequer Chamber, Court of. In Law, this court is, by 1 Wm. IV. c. 70, constituted the proper tribunal for the trial of writs of error from the three superior courts of common law. In this court the writ is tried before the judges, or judges and barons, of the two courts which had not given the former judgment. Error from this court lies in the House of Lords, which is the last and highest appellate tribunal of the country.

Exchequer, Chancellor of the. [CHANCELLOR OF THE EXCHEQUER.]

Exchequer, Court of. In Law, a court originally established for the recovery of the king's debts and ordinary revenues of the crown. In its modern shape, it is in fact a combination of eight distinct ancient courts. It acquired concurrent jurisdiction with the other two superior courts in all personal actions [COURTS, SUPERIOR] by the fiction of the complaining party being debtor to the king; a fiction which is now removed. It has exclusive jurisdiction in cases in which the king's revenue is concerned, whether personal actions or informations filed under the various revenue Acts. It had formerly also an equitable jurisdiction, abolished by 5 Vict. c. 5. [CHANCERY.] The chief and four puisné or younger judges of the Exchequer are termed *barons.*

EXCHEQUER, COURT OF (in Scotland). Established on its present footing by 6 Anne c. 26, it should consist of a chief baron and four junior barons; but three only have been commonly appointed. It has a privative jurisdiction as to duties of customs, excise, and other revenues of the crown.

Exchequer Tallies. One of the earliest and most lasting methods of checking accounts was by the use of tallies, which formed a rude but effective form of indenture. Hazel wands were provided, into which notches denoting different amounts were cut, and the rod was split, one half being retained by the office, the other held by the creditor of the exchequer. When presented for payment, the tallies were compared; and of course fraud was made difficult, if not impossible. A similar system lingers even yet in some rural districts and towns in the sale of milk and beer; one half of the stick being kept by the purchaser, the other by the seller, and fresh credits on account of the latter being entered by laying the sticks together and notching them. It is stated, especially in the trade between brewers and publicans, that the check afforded by this method against fraud in the trade is far more effectual than by the modern substitute of mutual account-books, and that the abandonment of the system has been an inconvenience.

The cancelled tallies of the exchequer accumulated to a vast amount, and an order was at last given for their destruction. It is said that, in consequence of a too liberal use of these wooden records, the houses of parliament were destroyed on the night of October 16, 1834.

Excise (Fr. from Lat. excido, *I cut* or *clip off*). The levy of duties on home manufacture intended for consumption within the country is said to have been one of the expedients adopted by the United Provinces of Holland during their struggle to achieve their political independence. It entered into the fiscal scheme of the Long Parliament in the year 1643, the tax being levied at first upon all beer and ale brewed. The king's parliament at Oxford imitated the action of the house at Westminster, and exacted, as far as possible, duties within the limits in which the king's authority was respected. Excises were continued during the Protectorate, though the impost was exceedingly unpopular.

At the Restoration, according to the principles laid down by the lawyers of the period, who held that, as Cromwell had not been king, the Act of Henry VII., giving validity to the laws passed by de facto monarchs, did not apply to the statutes of the parliamentarian régime, the feudal liabilities of the tenants in capite revived. The grievance of these liabilities was no doubt intolerable, and, as the preamble of the Act 12 Ch. II. cap. 24 expressed it, 'much more burdensome, grievous and prejudicial to the kingdom, than beneficial to the king.' But the remedy provided was not, as might have been expected, the levy of a land tax in accordance with a scheme proposed in the reign of James I., but the substitution of an hereditary excise on ale and beer, cider, perry, mead, spirits, coffee, tea, sherbet, and chocolate; in other words, the landowners of the period emancipated their own estates at other people's expense. From this time the excise became a permanent feature in English finance; the revenue derived being settled, up to the Revolution, on the king for life.

Under the wild system of taxation which prevailed during the eighteenth and part of the nineteenth centuries, no administration dreamed that the imposition of tax upon tax, excise upon excise, for the purpose of securing funds on which loans might be based, could ever fail to bring the revenue contemplated at the time in which the impost was created, or troubled itself about the effect likely to be

produced on industry by the introduction of the cumbrous, expensive, and vexatious enactments comprised under the general mass of excise Acts. Hence, while almost every conceivable article manufactured in England was made liable to an excise, and with it to hindrances to improvement, and the arbitrary interference of government officials, the administration actually levied duties on consumption upon those articles which already bore a customs duty on importation, and was perpetually lost in admiration at the miscalculations made as to the produce to the revenue of the impositions in question. The sole objects of governments, in short, was to get money; and the almost universal consequence of the expedients they adopted was to fail in procuring what they desired, and to succeed in cramping, distorting, or otherwise damaging the industrial energies of the community.

The chief inconvenience in an excise is that it generally interferes with the adoption of such processes as tend to diminish the cost of production. The officers appointed to supervise the production of excisable articles must needs have continual access to works in which the commodity is made; and as they are supposed to be perpetually on the look-out against the contingency of fraud, they are sure to object to mechanical or other improvements in the manufacture, on the ground that they have a tendency towards defrauding the revenue, even if, in the face of perpetual supervision, the manufacturer felt disposed to improve his process.

In accordance with the sounder theories of modern finance, the levy of an excise duty is limited to a few articles in universal consumption; and the system of bonding excisable articles is adopted as fully as in the importation of articles liable to a customs duty. Since the year 1851, the excises on bricks, soap, paper, and hops have been repealed, to the great advantage of the public. At present, the only articles chargeable with excise in the United Kingdom are malt, spirits, sugar, and chicory, the last two being very unimportant; and a powerful agitation, hitherto indeed unsuccessful, has been instituted with a view to the abolition of the excise on malt. Notwithstanding these reductions, however, the amount of revenue derived from the excise has largely increased since the period at which these reforms began; for instance, the gross proceeds of the excise in 1864 were eighteen and a quarter millions as compared with fifteen millions in 1850.

Excitability (Lat. excito, *I rouse*). A disposition to be affected by exciting causes. It is a term chiefly used in Medicine, in reference to that state of system which is more or less susceptible of morbid excitement.

Excitants (Lat. excito). Medicines which excite the actions of the system: they are either *general*, such as alcoholic liquors, &c., or *local*, such as diuretics, diaphoretics, &c.

Excito-motor Acts. In Physiology, this term has been applied to the first class of nervous actions defined as those sensory vibrations which are excited in the external organs and ascend towards the brain, when they arrive in their ascent at the origins of motor nerves. These, arising from the same common trunk, plexus, or ganglion, with the sensory ones affected, detach a part of themselves at each of those origins down the motory nerves; which part by agitating the small particles of the muscular fibres excites them to contraction. 'The actions of sneezing, swallowing, coughing, hiccoughing, vomiting, and expelling the fæces and urine, with others of a like nature, are to be deduced from the first and fourth classes of motor vibrations; i.e. either from those vibrations which first ascend up the sensory nerves, and then are detached down the motory nerves, which communicate by some common trunk, plexus, or ganglion; or else from those vibrations that run along the surfaces of uniform membranes, and so affect all the muscles which lie contiguous to any part of the membrane.' (Hartley *On Man*, p. 97.) 'The yawnings and stretchings of persons disposed to sleep, the convulsive respiration of those that are just fallen asleep, and the convulsive motions which attend the extinction of the senses in epileptic fits, and the near approach of death, may be derived, perhaps, in part, from this source.' (*Ib.* p. 93.) [MOTOR and REFLEX ACTION.]

Exclusion, Bill of. In English History, a bill introduced into parliament during the reign of Charles II. for the purpose of excluding the duke of York from the throne, as being a Papist.

Excommunication (Lat. excommunicatio). An ecclesiastical censure, by which a man is cut off from communion with his church. In the forms of excommunication of the Greek and Romish churches, the excommunicated person is solemnly devoted to the power of evil. The English church retains a form of excommunication, in cases of adultery, incontinence, heresy, simony, and neglect of public worship, &c.; the practice, however, has long become obsolete. In English law, excommunication was the ordinary mode by which contempt of the ecclesiastical jurisdiction was punished and its process enforced. Forty days after sentence the writ de excommunicato capiendo issued (called also a *significavit*, from the recital of the bishop's certificate with which it commenced), under which the party was apprehended by the sheriff. By stat. 53 Geo. III. c. 127, the legal effect of excommunication was abolished, and the writ de contumace capiendo substituted for the former one. Since the transfer of the chief branches of ecclesiastical jurisdiction to other courts, it has become virtually obsolete.

Excoriation (Lat. ex, and corium, *skin*). An abrasion of the cuticle.

Excrements (Lat. excrementum). Matters discharged from the intestinal canal. Their chemical composition has some important bearings on physiological questions and on their

application as manures. (Watt's *Chemical Dictionary*, art. 'Excrements.')

Excretine (Lat. excerno, *I separate from*). A name given by Marcet to a crystallisable substance extracted from fæces. (*Phil. Trans.* 1854.)

Excretories. The ducts which convey the secreted fluids from the glands.

Excurrent (Lat. excurrens, *running out*). In Botany, a term used in describing the ramification of any body whose axis always remains in the centre; the other parts being regularly disposed around it, as the stem of *Abies excelsa.*

Execution (Lat. exsecutio, *an accomplishment*). The carrying into effect of a judgment given in a court of law. Unless execution be taken out within a year and a day after the judgment has been given, the judgment must be revived by writ of scire facias. Execution may be against the person of defendant by imprisonment, which is under a writ of capias ad respondendum. There are also various writs of execution against the goods of a defendant and against his lands. Criminal execution is in the country directed by the judge of assize who tries the prisoner, and in London by the recorder.

Execution. In the Fine Arts, the mode of performing a work of art, and the dexterity with which it is accomplished.

The Dutch and early Flemish schools have hitherto attained the highest proficiency in execution.

Executive. In the theory of Government, that part of the powers of the state which is employed in putting into execution the laws made by the legislature or the decrees of the judicial power. In England, all executive power is supposed to be vested in the king, and in inferior officers by his delegation.

Executor (Lat. exsecutor, *one who performs*). In Law, an executor is a person appointed by a testator (the appointment being confirmed by the proper ecclesiastical court) to execute his will, and to represent him in his personal rights and liabilities. Thus the rights and liabilities of an executor in his representative capacity (the same as those of an administrator) are those of the testator or intestate, arising for or against him—either out of contract, or from injury done to his property, real or personal, or from injury done by him to the real or personal property of another; but the liabilities of an executor or administrator do not overreach the property or assets which he has received, or might but for his negligence or default have received, by virtue of his office.

The first and most important duty of executors and administrators is the payment of debts which attach to the property in their hands, in the following order (the reasonable expenses of the funeral, and the necessary expenses of proving the will, or of obtaining letters of administration, being first defrayed):—

1st. Debts due to the crown by record or on specialty.

2ndly. Debts due to the subject by virtue of the judgment of any court of record.

3rdly. Debts acknowledged upon record, as by recognisance.

4thly. Debts due upon specialty, or on account of rent.

5thly. Debts of the crown not upon specialty or record.

6thly. Debts by simple contract.

Creditors of each class are entitled to be paid in full before anything is allowed to debts of an inferior order; and as between themselves they are paid pro rata as far as the assets will extend. But an executor will be allowed, upon account, any debt that he may have paid without notice of another debt of a higher class: and as between creditors of equal degree, he may, before action brought at law, or decree to account in equity, give preference to any. He may also at any time as against creditors of an equal class retain a debt due to himself.

Next to debts stand, in the first place, specific legacies, i. e. gifts of specific parts of personal estate; and in the next place general legacies, that is, gifts of money payable out of the general residue of such estate: what remains after payment of legacies, where there are any, or, where there are none, after payment of debts, is divisible among the next of kin according to the Statute of Distributions. Specific legacies may be recovered at law; but the rights of general legatees, and of next of kin, are enforceable only in courts of equity or in the ecclesiastical courts.

Most frequently also claims in the nature of debt or legacy to which the personal estate of testators or intestates is subject are prosecuted in courts of equity; which do not only, like courts of law, take cognisance of each individual right as brought forward, but will take upon themselves the whole administration of the estate, and retain it in their hands for the purpose of doing justice to all claimants.

In so doing courts of equity are bound to follow the legal order of priority above stated, so far at least as the assets are legal; i. e. either recoverable in courts of common law, or arising upon trust direct and proper, and coextensive with the legal interest [Trust], to which the principle of *æquitas sequitur legem* applies. But where there are assets recoverable only in equity, and arising upon implied or resulting trusts, these are called *equitable*; and in the application of such assets the rule obtains of equality between all debts, the priority of debts to legacies, and among these of specific to general, being still observed. Where there are both legal and equitable assets, creditors availing themselves of their priority against the legal assets will not be admitted to any participation in the equitable assets till other creditors shall have received out of them the same proportion of their debts as shall have been already paid to the creditors of a higher degree out of the legal assets.

By 3 & 4 Wm. IV. c. 104 real estate not devised for or charged with the payment of

debts is made assets for the payment of all debts, to be administered by courts of equity according to the legal order of priorities; but real estate so devised or charged still remains, as before, equitable assets. Executors and administrators, as such, have no concern in either case with the application of real assets.

Many questions arise in regard to legacies—as to when they are vested, when specific or general—which it is impossible to notice within the limits of this summary.

Exegesis (Gr. *explanation*). The term applied most usually to the exposition or interpretation of the Holy Scriptures; it is also used, however, in an unrestricted sense.

Exergue (Fr.). In Numismatics, the basis or lower limb of a coin or medal, when separated by a line from the rest of the face, which usually contains words giving the date, place, &c. of the coin, or other subsidiary matter. [NUMISMATICS.]

Exfoliation (Lat. folium, *a leaf*). The separation of a piece of dead bone from the living, as of leaves from a tree.

Exhalation. [VAPOUR; EVAPORATION.]

Exhaustion (Lat. exhaurio, *I draw out*). An ancient geometrical method which has been replaced by the modern differential calculus. The ancients employed this method in their difficult researches, particularly in the theory of curve lines and surfaces, and in determining areas and volumes. As they admitted no demonstrations but such as are perfectly rigorous, they did not consider curves as polygons of a great number of sides; but in attempting to discover the properties of any curve, they regarded it as the fixed term or limit to which the inscribed and circumscribed polygons continually approach, and approach the nearer as the number of their sides is increased. Thus they *exhausted*, as it were, the space between the polygons and the curve; and hence this method of procedure was called the *method of exhaustion*. When the properties of a curved line or surface were thus divined, however, it was usual to give an indirect geometrical demonstration of them, by showing that every contrary hypothesis must necessarily lead to a contradiction or absurdity.

Exhedra (Lat.; Gr. ἐξέδρα). In ancient Architecture, a small room in the baths and other buildings appropriated for conversation. The name was especially applied to the hall in Pompey's theatre at Rome.

Exheredation (Lat. exhæredatio). In the Civil Law, the exclusion of a child from inheriting any part of his father's estate. (Sandars's *Justinian*, 278.)

Exhibit (Lat. exhibitus, part. of exhibeo, *I show*). In Law, any paper produced in a court of law or equity; or in the latter referred to in affidavits and certified.

Exhibition. A term applied in modern times to the public display of works of art. This word is also used to denote private benefactions instituted for the maintenance of scholars in the universities. [BURSARS.]

Exigi Facias or **Exigent.** In Law, a writ which, since the abolition of outlawry on mesne process, is only used for the purpose of proceeding against a debtor to outlawry on final process. [OUTLAWRY.]

Exile (Lat. exsilium). In Roman law, the punishment of banishment, or, more strictly speaking, the consequence of the interdiction from the use of fire and water, pronounced as a sentence against great offenders, compelling them to expatriate themselves. It appears that the direct sentence of exile was not known to ancient Roman jurisprudence. (Cicero *ad Herenn.*) In modern France (before the Revolution), there was a distinction between banishment and exile. The former was a punishment assigned by the law, and producing infamy; the latter a measure of discipline, inflicted by the arbitrary act of the monarch (usually through lettres de cachet). Thus political offenders were frequently exiled to their estates, to a certain distance from court, &c.

Exintine (Lat. ex, *from*, and intus, *within*). In Botany, a membrane situated between the extine and intine in the pollen of yew, juniper, cypress, &c.

Existence. [PERCEPTION; MATERIALISM.]

Exocœtus. [FLYING FISH.]

Exochnata. A designation of the long-tailed *Crustacea*; as the lobster and shrimp.

Exodium (Gr. ἐξόδιον, from ἔξοδος, *a going out*). In Greek Tragedy, the final chorus of a play. At Rome, the exodia were burlesques acted after other plays.

Exodus. [PENTATEUCH.]

Exogenous. In Botany, growing by additions to the outer surface of the stem, as in the case of our European timber-trees.

Exogens (a word coined from Gr. ἔξω, *without*, and γίνομαι). One of the primary classes into which the Vegetable world is divided. It is characterised by having the leaves reticulated; the stems with a distinct deposition of bark wood and pith; the embryo with two cotyledons; and the flowers usually formed on a quinary type. A transverse slice of the stem exhibits a central cellular substance or pith, an external cellular and fibrous ring or bark, and an intermediate woody mass, with certain fine lines radiating from the pith to the bark through the wood, called *medullary rays*. They are called *Exogens* because they add to their wood by successive external additions.

Exogonium (Gr. ἔξω, and γόνυ, *a knee*). A genus of *Convolvulaceæ*, comprising the plant which yields Jalap. This plant, a native of Mexico, is called *E. Purga*, and is a climber, with cordate ovate leaves, and pretty salver-shaped purplish flowers, having a long, straight, slender tube. The Jalap roots of commerce are roundish dark-coloured bodies of variable size, and owe their purgative properties to the resinous ingredients in their composition. [JALAP.]

Exomphalos (Gr.). A hernia or rupture at or near the navel.

Exophthalmia (Gr. ἔξω, and ὀφθαλμός, *the eye*). The protrusion of the eyeball from the

orbit. It is usually the consequence of concussions or blows; sometimes it is produced by a tumour in the orbit, which gradually pushes the eyeball out of its socket.

Exophyllous (Gr. ἔξω, and φύλλον, *a leaf*). A term applied to the young leaves of Exogens, since they are said to be always naked, while those of Endogens sheathe each other.

Exoptiles (Gr. ἔξω, and πτίλον, *a feather*). A term for Dicotyledonous plants, because their plumula is naked.

Exorcism (Gr. ἐξορκισμός). The solemn adjuration by which those endowed with certain powers were believed to subject evil spirits to their obedience: more particularly to compel them to leave the bodies of those supposed to be subject to demoniacal possession. The exorcists form one of the minor orders in the church of Rome.

Exordium (Lat. *a beginning*). In Oratory and Literature, the opening part of an oration.

Exorrhizae (Gr. ἔξω, and ῥίζα, *a root*). A term applied to the embryo of Dicotyledons; inasmuch as their radicle always elongates downwards, directly from the outside of the base of the embryo.

Exosmose (a word made up from Gr. ἐξ, and ὠσμός, *impulsion*). The passage of gases, vapours, or liquids through membranes or porous media from within outwards. M. Dutrochet found that if two fluids of unequal density are separated by an animal or vegetable membrane, the denser will attract the less dense through the membrane that divides them: this property he called *endosmose* when the attraction is from the outside to the inside: and *exosmose* when it operates from the inside to the outside of the body acted upon. [ENDOSMOSE.]

Exostome (Gr. ἔξω, and στόμα, *a mouth*). In Botany, a term invented to denote the passage through the outer integument of an ovule, commonly called the *foramen*.

Exostosis (Gr.). In Anatomy, a swelling or tumour of a bone.

EXOSTOSIS. In Botany, a disease to which the roots and stems of trees are subject, when knots or large tumours are formed upon or among the wood. It is caused by a stoppage of growth on the one hand, and an attempt at excessive developement on the other. It is from sections of the exostoses of trees that some of the most beautiful wood used by cabinet-makers is obtained. These knots are sometimes called *knaurs*.

Exostra (Gr. ἐξώστρα). In ancient Architecture, a machine for representing the interior part of a building, as connected with the scene of a theatre.

EXOSTRA. In ancient Military art, a bridge thrust out of a turret upon the wall of a town, by which the besiegers obtained an entrance.

Exoteric. [ESOTERIC.]

Exothecium (Gr. ἔξω, and θήκη, *receptacle*). In Botany, that portion of an anther from which the pollen is incorrectly supposed to separate; it is the coating of the anther.

Exotic (Gr. ἐξωτικός, *foreign*). Anything introduced into one country from some other country. In Gardening, it is sometimes applied to plants which require protection in winter, or to plants in general which are not European.

Expansion (Lat. expando, *I open out*). One of the most common and obvious effects of heat, which expands or enlarges the bulk of all the forms of matter. The expansion of solids by increase of temperature is comparatively small; but it may be rendered sensible by carefully measuring the dimensions of any substance when cold, and again when heated: an iron bar, for example, fitted to a gauge, which shows its length and breadth, will no longer pass through the apertures when heated. Among solids the metals are most expansible and contractile by heat and cold; but they vary much in this respect, as shown in the following table, which exhibits the change of dimensions which several of them undergo when heated, from the freezing to the boiling point of water:—

	Temperature	
	32°	212°
Platinum	120,000	120,104
Steel	—	120,147
Iron	—	120,151
Copper	—	120,204
Brass	—	120,230
Tin	—	120,290
Lead	—	120,245
Zinc	—	120,360

The average expansion of glass is very nearly the same as that of platinum.

The expansibility of different *liquids* is also very variable; ether for instance, and alcohol, are more expansile than water, and water more than mercury. The expansibility of mercury is applied to a very useful purpose in the construction of the common thermometer.

In general, all liquids expand and contract in proportion as they are heated and cooled; but to this law there is a remarkable and anomalous exception in regard to *water*. When a large thermometer tube is filled with water of the temperature of 60°, and placed in a cold situation, or in a vessel filled with pounded ice, the water goes on shrinking in the tube till it has attained the temperature of about 40°; and then, instead of continuing to contract till it freezes (as is the case with other liquids), it slowly *expands*, and actually rises in the tube until it reaches the freezing point. In this case, the expansion above 40° and below 40° seems to be equal; so that water will be of the same bulk at 48° and at 32°. This anomalous expansion of water by cold is productive of some important consequences, considered as a natural operation; for if water, like other fluids, went on increasing in density till it froze, the consequence would be that large bodies of water, instead of being only superficially frozen in winter, would be converted throughout into solid masses of ice. Let us take a fresh-water lake as an example. The earth being in winter

warmer than the air, the heat is withdrawn from the surface of the water by the cold breezes that blow over it; and the whole body of water has its temperature lowered to 40°, *which is the point of its greatest density*—a temperature perfectly congenial to fish and most other aquatic animals. The cold now continues to operate upon the surface of the water; but, instead of diminishing its bulk, and therefore rendering it *heavier* than the warmer water beneath, the cold expands it, and renders it *lighter*; so that under these circumstances a stratum of ice-cold water (at 32°) will be found lying upon the mass of warmer water beneath it (at 40°). The influence of the cold continuing, the surface of the lake will soon freeze, but the water immediately below the superficial covering of ice will be found comparatively warm; and as water is almost a non-conductor of heat, it will be a long time before the ice attains any thickness; and the whole body of water, if of any depth, can never freeze throughout. Indeed, it will be obvious that the retardation of freezing will be proportional to the depth of water which has to be cooled; and hence some very deep basins or lakes are under ordinary circumstances scarcely ever even covered by ice.

As liquids are *enlarged* and consequently rendered specifically lighter by heat, very different effects are produced by applying heat to different parts of the vessels containing them. If the heat be applied to the bottom of the vessel, the liquid is soon heated equally throughout, and made to boil; but if the surface only be heated, it may then be boiled and evaporated, while the lower parts remain quite cold.

Aëriform bodies and vapours are the most expansible forms of matter, and they present an important peculiarity; for in other substances each individual has its own degree of expansion and contraction, whereas all aëriform bodies expand and contract alike; so that if we accurately determine the expansion and contraction of any one of them, that knowledge applies to all the rest. 100 measures of air when heated from the freezing to the boiling point of water, suffer an increase of bulk equal to 37·5 parts; so that 100 cubic feet of air at 32° become dilated to 137½ cubic feet at 212°.

Expansion Gear. The machinery fitted to an engine for the purpose of cutting off the steam at different portions of the stroke, according to the amount of work required to be effected by the engine. The steam in these cases is allowed to enter the cylinder at the pressure under which it is generated; it is then cut off, at the portion of the stroke the engineer thinks fit; and finishes the stroke by its natural expansion. Sometimes the term *expansion joint* is applied to such joints as are made with a stuffing-box or an elastic junction on their length, which will allow them to expand freely under the effects of the alteration of temperature to which they may be exposed by the passage of steam through the pipes.

Expectation of Life. By this term writers on annuities and reversions express the mean duration of human life, after a specified age, according to a given table of mortality. With regard to an individual of a given age, the *expectation of life* is the mean number of future years which individuals of that age, one with another, actually live. The *expectation of life*, according to this definition, differs altogether from what is called the *probable life*. The latter term denotes the period at the end of which the probability of being alive is equal to that of being dead, or is equal to ½; and this is manifestly the period in which the number of lives in the table, beginning with any given age, is reduced to one-half. Thus, if in a given table of mortality we find that 1,000 individuals are living at the age of 40, and that of these 500 only are living at the age of 63, then the *probable life* of an individual aged 40, according to that table, would be 23 years; that is to say, it is an even wager whether he will be alive or dead at the end of 23 years. The *mean life*, or *expectation of life*, is, however, quite different in principle (though in most tables not very different in amount), and depends on the same mathematical probabilities of living over each future year of life, to the last in the table, as are employed in the calculation of life annuities. It is computed as follows:—

Let the probabilities that a life of a given age will live over

1, 2, 3, 4 . . . x years,

be p_1 p_2 p_3 p_4 . . . p_x respectively; then the probability that the life will fail in any given year x, is $p_{x-1}-p_x$.

Now, in computing the portion of existence which an individual may expect to enjoy in respect of any future year x, there are two contingencies to be considered: 1st. The individual may live over that year, in which case he will enjoy a whole year of life $=1$. But the probability of this event is p_x; therefore

$$p_x \times 1 = p_x$$

is the portion of time he may at present expect to live in respect of that year. 2nd. The individual may die in the course of that year; and as the chances of dying at any particular part of the year are equal, we must suppose him to die at the middle of the year; in this case, therefore, he enjoys half a year of life $=\frac{1}{2}$. But the probability that his death will happen in the xth year is $p_{x-1}-p_x$; consequently

$$\tfrac{1}{2}(p_{x-1}-p_x)$$

is the portion of time he may hope to live, in respect of that year, on the second contingency.

Adding the two results together, we get

$$p_x+\tfrac{1}{2}(p_{x-1}-p_x)=\tfrac{1}{2}(p_{x-1}+p_x)$$

for the whole of his expectation of life in respect of the x^{th} year from the present. Substituting successively the numbers 1, 2, 3, &c. for x, in order to get the expectation for each succeeding year till the last age in the table, and denoting the sum of the expectations by E, we find (since $p_0=1$)

$$E=\tfrac{1}{2}(1+p_1+p_2+p_3+\&c.)$$
$$+\tfrac{1}{2}(p_1+p_2+p_3+\&c.);$$

consequently,

$$E=\tfrac{1}{2}+p_1+p_2+p_3+\&c. \ldots \quad (1).$$

Thus it appears that the true value of the expectation of life is equal to the sum of the probabilities of the life enduring through 1, 2, 3, &c. years to the limiting age of the table of mortality, increased by $\frac{1}{2}$. The labour that would be required to sum this series for every different age is avoided by deducing the expectation of one age from that of the next older, as is usually done in computing annuity tables. Thus, let E_1 denote the expectation of life for an individual one year older than the former, and let the probabilities of his living over 1, 2, 3, &c. years be respectively q_1, q_2, q_3, &c.; then we must have

$$E_1=\tfrac{1}{2}+q_1+q_2+q_3+\&c. \ldots \quad (2).$$

But from the nature of the probabilities in question,

$$p_2=p_1\,q_1,$$
$$p_3=p_1\,q_2,$$
$$p_4=p_1\,q_3, \ \&c.$$

Substituting, therefore, these values in (1), we find

$$E=\tfrac{1}{2}+p_1\,(1+q_1+q_2+q_3+\&c.)\,.\,.(3).$$

Whence, on eliminating $q_1+q_2+q_3+\&c.$, from the two equations (2) and (3), we get

$$E-\tfrac{1}{2}=p_1\,(E_1+\tfrac{1}{2}),$$

which is the most convenient form under which the formula can be put for computation.

For the explanation of the manner in which the probabilities $p_1\,p_2\,p_3$, &c., are determined from the ordinary tables of mortality, see ANNUITY.

The following table, from Mr. Milne's *Treatise on the Valuation of Annuities and Assurances* (vol. ii. p. 565) shows the expectation of life at every age, according to the law of mortality at Carlisle:—

Age	Expectation	Age	Expectation	Age	Expectation	Age	Expectation
0	38·72	26	37·14	52	19·68	78	6·12
1	44·68	27	36·41	53	18·97	79	5·80
2	47·55	28	35·69	54	18·28	80	5·51
3	49·82	29	35·00	55	17·58	81	5·21
4	50·76	30	34·34	56	16·89	82	4·93
5	51·25	31	33·68	57	16·21	83	4·65
6	51·17	32	33·03	58	15·55	84	4·39
7	50·80	33	32·36	59	14·92	85	4·12
8	50·24	34	31·68	60	14·34	86	3·90
9	49·57	35	31·00	61	13·82	87	3·71
10	48·82	36	30·32	62	13·31	88	3·59
11	48·04	37	29·64	63	12·81	89	3·47
12	47·27	38	28·96	64	12·30	90	3·28
13	46·51	39	28·28	65	11·79	91	3·26
14	45·75	40	27·61	66	11·27	92	3·37
15	45·00	41	26·97	67	10·75	93	3·48
16	44·27	42	26·34	68	10·23	94	3·53
17	43·57	43	25·71	69	9·70	95	3·53
18	42·87	44	25·09	70	9·18	96	3·46
19	42·17	45	24·46	71	8·65	97	3·28
20	41·46	46	23·82	72	8·16	98	3·07
21	40·75	47	23·17	73	7·72	99	2·77
22	40·04	48	22·50	74	7·33	100	2·28
23	39·31	49	21·81	75	7·01	101	1·79
24	38·59	50	21·11	76	6·69	102	1·30
25	37·86	51	20·39	77	6·40	103	0·83

Expectorants (Lat. expectorare, *to expectorate*). Medicines which increase the secretion of the tracheal and bronchial mucus. The term *expectoration* is applied to anything cast off from those vessels or from the cells of the lungs by spitting or coughing.

Expectoration (Lat. expectorare). The act of ejecting matters from the chest. The term is sometimes applied to the matter ejected, which is, however, more properly termed *sputum*.

Expenditure (Lat. expendo, *I pay out*). In Finance, the charges levied annually on the community for the public service. The items of the public expenditure are generally tabulated under four great heads: 1. The interest and management of the public debt; 2. The civil list and civil charges of all kinds; 3. The forces; 4. The charge of collection.

Up to 1854 it was the practice to complete the financial year on the 5th of January. In this year, however, a change took place; and it was arranged for the convenience of the administration that the financial year should end on the 31st of March. As a rule, the expenditure of the country for the forthcoming year is the first duty of parliament in the vote of supplies, the budget of the Chancellor of the Exchequer being based upon the supply granted. If extraordinary expenses become necessary, a supplementary budget is prepared.

The following is the amount of gross expenditure for the last fifteen years:—

Years ended Jan. 5,	Years ended Mar. 31,
£	£
1850. 55,287,532.	1856. 92,986,737.
1851. 54,745,176.	1857. 76,042,570.
1852. 53,850,445.	1858. 68,128,859.
1853. 55,117,656.	1859. 64,663,883.
1854. 55,647,991.	1860. 69,502,289.
Qr. to April 5,	1861. 72,842,059.
1854. 14,012,164.	1862. 72,086,485.
Mar. 31,	1863. 70,352,008.
1855. 69,012,760.	1864. 67,856,286.

During the last four years 2,870,000*l.* have been raised for fortifications on terminable annuities, this sum being included in the expenditure. Of the several charges enumerated above, the interest and management of the debt has diminished; while the expenditure for civil and military purposes has greatly increased.

Experimentum Crucis (Lat.). Bacon's *Crucial*, or *decisive* experiment (so called from the *crosses*, or finger-posts on roads), as at once determining between two or more possible conclusions.

Expiation (Lat. expiatio). In its most extended meaning, the act by which a guilty person makes atonement to religion, morals, or society at large, for any crime or fault, whatever be its nature or extent. In most of the ancient religious systems the idea of expiation was confined to cases of blood-shedding; and its growth can be traced through the practice of compensation in money to a fixed ceremonial administered by kings or priests.

This ceremonial varied with the character of every nation and the nature of the crime which it was intended to expiate. Among the Greeks and Romans, expiations were sometimes made for whole cities. There is no mention of the practice of expiation for murder in the Homeric poems. (Grote's *History of Greece*, part i. ch. i.) [SACRIFICE.]

Expiration (Lat. exspiratio). In Physiology, the movements by which the air that has been changed by the respiratory process is expelled from the lungs; they are chiefly due to the elastic contraction of the lungs and the walls of the chest, after they have been dilated in the act of inspiration.

Explicit Function. A variable is said to be an *explicit function* of several others when its value, expressed in terms of those of the independent variables, is given. Thus, if

$$z = ax^2 + 2bxy + cy^2,$$

z is said to be an explicit function of x. If on the other hand z were connected with x and y by an equation of any other form, it would be called an *implicit function* of the latter.

Explosion (Lat. explosio). In Natural Philosophy, a sudden and violent expansion of the parts of any object. Explosion differs from expansion in this, that whereas the former is always sudden, and only of momentary duration, the latter is the effect of some gradual and continued power, acting uniformly for some considerable time. [EXPANSION; MATTER, PROPERTIES OF.]

Exponent (Lat. expono, *I set out*). In Algebra, a number, or a symbol representing a number, which when written above and to the right of any symbol of quantity, indicates that a corresponding power of that quantity is to be taken. Thus a^3 denotes the *third power of a*, and 3 is said to be the *exponent* or index of *that power*; usually, though less strictly, it is called *the exponent of a*. Thus a^3 is merely an abbreviation for $a\ a\ a$, and from the definition of an exponent it follows at once that $a^{m+n} = a^m a^n$. The notation of exponents was introduced by Descartes, and being extremely convenient was soon extended. The convention upon which the extension is based is the *general* truth of the last equation. Thus if we ask for the meaning of a negative or fractional exponent, on the hypothesis that the last equation shall hold for all values of m and n, we find that since

$$a^m = a^{m+0} = a^m a^0,$$

a^0 must be a symbol for 1, no matter what a represents. Similarly, a^{-m} must denote the reciprocal of a^m, since

$$a^{m-m} = a^m a^{-m} = a^0 = 1.$$

Again, a fractional exponent must, consistently with the above convention, indicate that a certain root of a power is to be taken. Thus the symbols

$$a^{\frac{2}{3}},\ \sqrt[3]{a^2}$$

ought to have the same meaning; for according to the conventional *law of exponents*,

$$a^{\frac{2}{3}}\ a^{\frac{2}{3}}\ a^{\frac{2}{3}} = a^{\frac{2}{3}+\frac{2}{3}+\frac{2}{3}} = \left(a^{\frac{2}{3}}\right)^3 = a^2.$$

The exponential notation was subsequently extended to symbols of operation. Thus if ϕ indicate any operation to be performed upon a quantity x, and $\phi(x)$ denote the result of that operation, $\phi^2(x)$ would denote the result of operating, in a similar manner, upon the former result $\phi(x)$. For instance,

$$\phi(x) = 1 + 2x,$$

then

$$\phi^2(x) = \phi[\phi(x)] = 1 + 2(1 + 2x) = 3 + 4x.$$

Separating the symbols of operation and quantity, we might write as before,

$$\phi^{m+n} = \phi^m \phi^n,$$

and draw analogous conclusions. Thus, ϕ^0 would indicate an operation which, like the multiplication by unity, produces no change on the subject; that is to say, $\phi^0(x) = 1x = x$. Again, ϕ^{-1} would indicate an operation whose effect is cancelled by the direct operation ϕ, and $\phi^{\frac{2}{3}}$ would denote an operation which, repeated three times successively, yields the same result as the performance, twice successively, of the operation ϕ.

Exponential Equation. An equation which involves terms wherein the unknown quantity appears as an exponent or as a constituent of an exponent. The simplest form of exponential equation is $a^x = b$; one of its solutions is the *logarithm of b to the base a*, or, what is the same thing, the ratio of the logarithm of b to that of a, the bases being the same, but arbitrary. This is only one solution; the equation has innumerable other imaginary roots, and is consequently *transcendental*. A curve in whose equation the coordinates appear as exponents is, in like manner, called an *exponential curve*. The *logarithmic curve* may serve as an example.

Exponential Theorem. The expression of a number in ascending powers of its logarithm. It may be thus obtained:

$$\left(1+\frac{1}{n}\right)^{nx} = 1 + x + \frac{x\left(x-\frac{1}{n}\right)}{1\,.\,2} + \frac{x\left(x-\frac{1}{n}\right)\left(x-\frac{2}{n}\right)}{1\,.\,2\,.\,3} + \text{\&c.},$$

by the binomial theorem. By putting $x=1$, and raising the result to the x^{th} power, this series, which is convergent for all values of $\frac{1}{n}$ less than unity, will manifestly be reproduced, and on supposing n to be infinitely great in the two identical series thus obtained, we have

$$1 + x + \frac{x^2}{1\,.\,2} + \frac{x^3}{1\,.\,2\,.\,3} + \text{\&c.},$$

$$= \left[1 + 1 + \frac{1}{1\,.\,2} + \frac{1}{1\,.\,2\,.\,3} + \text{\&c.}\ \ldots\right]^x = e^x.$$

The number here represented by e has the value 2·7182818284 . . . , and is termed the

base of the natural or Napierian system of logarithms. The above is the exponential theorem in its simplest form; it is convergent for all values of x. Putting $x \log_e a$ in place of x, and observing that $e^{\log_e a} = a$, it becomes

$$a^x = 1 + (\log_e a)\,x + \frac{(\log_e a)^2}{1\,.\,2}\,.\,x^2 + \&c. \ldots,$$

which is the complete exponential theorem. If a^x be put in the form

$$[1 + (a-1)]^x,$$

and expanded by the binomial theorem, the coefficient of x, which by the above series is $\log_e a$, will be found to be

$$(a-1) - \tfrac{1}{2}(a-1)^2 + \tfrac{1}{3}(a-1)^3 \ \&c. \ldots;$$

whence, putting successively $1+x$ and $1-x$ in place of a and deducting the results, is obtained the series,

$$\log_e\left(\frac{1+x}{1-x}\right) = 2\left\{x + \frac{x^3}{3} + \frac{x^5}{5} + \&c. \ldots\right\},$$

by means of which natural logarithms may be calculated, and thence all others. [LOGARITHMS.]

Exports (Lat. exporto, *I carry out*). The commodities manufactured at home for the purpose of exchange against the productions of foreign countries, and shipped for that end, are popularly called by this name. These exports are valued at the time of shipment, and, as a rule, pay for the imports; the difference in value between the estimated price of imports and exports being, minus the charge of carriage, the profit of trade.

The following is the declared real value of British and Irish produce exported during the last sixteen years:—

	£		£
1849.	63,596,025.	1857.	122,066,107.
1850.	71,367,885.	1858.	116,608,756.
1851.	74,448,722.	1859.	130,411,529.
1852.	78,076,854.	1860.	135,891,227.
1853.	98,933,781.	1861.	125,102,814.
1854.	97,184,726.	1862.	123,992,264.
1855.	95,688,085.	1863.	146,489,768.
1856.	115,826,948.	1864.	160,436,000.

There is, however, another, and still more important sense, in which exports may be understood; that is, as including not only all manufactures and other goods shipped to foreign countries in payment of imports, but all the capital which seeks a more remunerative investment in foreign countries. This exportation of capital, though, comparatively speaking, scantily taken account of in investigating the trade of a country, produces most important effects on the foreign exchanges, and ultimately on prices at home; for when the amount of such investments or loans is added to the rest of the exports, it may induce an adverse state of the exchanges, necessitate the efflux of bullion, and, in order to arrest such an efflux, compel the levy of a high rate of discount, and, by forcing exportation at lower prices, diminish the rate of profit achieved by the manufacturer or producer.

Expression (Lat. expressio). In the Fine Arts, the representation of the various passions of the mind.

Exserted (Lat. exsertus, *thrust out*). In Botany, a term applied to stamens when longer than the corolla.

Exsiccator (Lat. exsicco, *I dry up*). An apparatus for drying humid substances, consisting generally of a chamber through which a current of warm and dry air may be passed, and which may contain sulphuric acid, quicklime, or other substances which readily absorb aqueous vapour.

Extensor Muscles (Lat. extendo, *I stretch out*). As opposed to *flexor muscles*, those which extend any limb or part; the muscle in the fore-arm which extends the joints of the fingers, called the *extensor digitorum*, is an instance.

Extent. In Law, a writ of execution (sometimes called an *extendi facias*), directed to the sheriff, against the body, lands, and goods, or the lands only, of a debtor. Writs of extent were of two kinds—*extent in chief*, and *extent in aid*; to both of which the king was entitled by ancient prerogative, for the purpose of obtaining satisfaction of debts originally due to him, or assigned to the crown. The writ of *extent in chief* is a proceeding by the king for the recovery of his own debt, and in which he is the real plaintiff. The writ of *extent in aid* is also sued out at the instance and for the benefit of the crown against the debtor of a crown debtor; but in this proceeding the crown is the nominal plaintiff only, the party proceeding under the writ of ELEGIT [which see]. Under this writ the lands, tenements, and possessions, as well as the person of the defendant, may be taken in execution; and if within seven days he do not liquidate the debt, a writ of *venditioni exponas* is issued to sell the same; the crown claiming a priority of satisfaction over every other creditor.

Extine. The external membrane of the pollen grain of plants. [EXINTINE.]

Extract or **Extractive Matter** (Lat. extractus, part. of extraho, *I draw out*). The term *extract* is applied in Pharmacy to the brown substance which remains after the evaporation of certain decoctions or infusions of vegetables; thus we have *extract of bark*, *extract of rhubarb*, and so on. These extracts are usually mixtures of various soluble matters, along with a certain portion of a peculiar vegetable principle of a brown colour, or which becomes so by exposure to air, and which is soluble in water and in alcohol, but scarcely soluble in ether. It combines with alumina, and is often the basis of brown dyes: it is this principle which chemists call *extractive*, and which is frequently closely allied to various forms of colouring matter.

Extract of Lead. A term applied to the impure subacetate of lead obtained by boiling litharge in vinegar. It was first used by a

surgeon of the name of Goulard, and hence called *Goulard's extract of lead.*

Extraction of Roots. In Arithmetic, the operation whose object is the discovery of the number which, when multiplied by itself a stated number of times, yields a given result. [EVOLUTION.] An interesting account of the progress made in the extraction of roots up to the year 1819, when Horner's admirable method was published in the *Phil. Trans.*, will be found in the *Companion to the British Almanack* for 1839.

Extradition (Lat. ex, and trado, *I hand over*). In International Law, the obligation of a state to surrender subjects of a foreign state charged with legal offences committed in such foreign state. This has been held by great jurists (Grotius among others) to follow from the comity of nations. Others deny this; and in practice, extradition is only made in cases where a convention to this effect subsists between two powers, as between England and France (February 1843), and the United States (August 9, 1842), enforced by stat. 6 & 7 Vict. c. 75, and 8 & 9 Vict. c. 120. (Phillimore's *International Law*, ch. xxi.) The rule of refusing the extradition of political refugees has been always maintained by Great Britain, and generally by civilised powers powerful enough to adhere to it. But Austria, Russia, and some of the German powers, have special treaties for this purpose.

Extrados (Fr.). The external outline, or curve, of an arch. Generally the term is used to denote the upper curve of the voussoirs, or stones, which immediately form the arch.

Extravagantes Constitutiones (Low Lat.). In the Canon Law, certain papal constitutions not included in the Corpus Juris Canonici are so called, and comprised in a separate volume. They are those of John XXII. and a few of his successors in the papacy.

Extravaganza (Ital.). In the Drama, pieces usually composed regardless of rules, and generally of the burlesque kind.

EXTRAVAGANZA. In Music, a kind of wild and incoherent composition.

Extravasation (Lat. extra, *external to*, and vas, *a vessel*). A term applied to fluids when out of their proper receptacles or vessels. Thus when blood is thrown out upon the brain, or into any cavities of the body, it is said to be extravasated.

Extreme (Lat. extremus). In Logic, has the same meaning with *term*, when used in reference to a proposition. The subject and predicate are the two extremes of a proposition, the copula being, as it were, placed between them. In speaking of a syllogism, the extremes are understood to mean the extremes or terms of the conclusion.

EXTREME. In Music, a word employed in describing those intervals in which the diatonic distances are increased or diminished by a chromatic semitone.

Extreme and Mean Ratio. A straight line is said to be divided in extreme and mean ratio when the whole is to the greater part as the greater part to the less; or when the rectangle contained by the whole line and the smaller segment is equal to the square of the greater segment. Euclid shows how a line may be divided in this manner, in the eleventh proposition of his second book; and it is by means of this proposition that he constructs a regular decagon on a given straight line.

Extreme Unction (Lat. unctio, *an anointing*). One of the seven sacraments of the Romish church, founded on the passage in the Epistle of St. James, 'If any be sick among you, let him call upon the elders of the church, and let them pray over him, anointing him with oil in the name of the Lord' (v. 14). This ceremony is supposed to purify the soul of the dying person from any sins that he may have committed, and which have not been previously expiated by participation in the other means of grace.

Extremities. In Painting and Sculpture, the head, the hands, and the feet. In Zoology, the arms and legs, and analogous members in the lower animals.

Extrorse or **Extrorsal.** In Botany, a term used in describing the direction of bodies, to denote their being turned from the axis to which they appertain; thus anthers, whose line of dehiscence is towards the petals, are said to be *extrorse.*

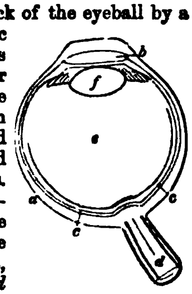
Extroversion. A term applied by surgical writers to those malformations of the body in which a part is, as it were, turned wrong side outwards. Such cases are congenital; thus cases are on record of *extroversion of the bladder*, in which there is a congenital defect of its anterior part, and of the corresponding portion of the parietes of the abdomen, so that the internal surface of the bladder projects and forms a tumour.

Exuviæ (Lat. *that which is cast off from the body*). This term was applied by the Roman naturalists and poets to the shed skin of the snake. It is extended in modern Zoology to the external layer of the integument of every animal, when it is periodically shed entire or in large portions. The films of mucus thrown off from the external surface of most zoophytes and molluscs may be regarded as exuviæ; also those portions of the shell which are deserted and partitioned off by a new-formed plate, as in the *Spondylus varius*, and chambered univalve shells; but the exuvial layers are retained by adhesion to the last secreted portion of the shell. In insects the whole integument is shed generally several times in succession, the last *ecdysis* taking place in the transition from the pupa to the imago state. In the *Crustacea* the exuvial shell is commonly cast annually; the cephalothorax or carapace cracks longitudinally down the back, and the limbs are withdrawn after successive painful efforts; the lining membrane of the stomach is at the same time shed.

Fishes seem to cast off exuvial layers of mucus only; but in most reptiles the epidermis is

periodically moulted, either entire or in large coherent masses. In some species the moulting could only have been detected by careful watching, as the main evidence, the cast skin, is made away with the moment the operation is ended. Mr. Bell thus describes the *ecdysis* of the common toad: 'On watching carefully, I one day observed a large toad, the skin of which was particularly dry and dull in its colours, with a bright streak down the mesial line of the back; and on examining further, I discovered a corresponding line along the belly. This proved to arise from an entire slit in the old cuticle, which exposed to view the new and brighter skin underneath. Finding therefore what was about to happen, I watched the whole detail of this curious process. I soon observed that the two halves of the skin thus completely divided continued to recede further and further from the centre, and become folded and rugose; and after a short space, by means of the continued twitching of the animal's body, it was brought down in folds on the sides; the hinder leg, first on one side and then on the other, was brought forward under the arm, which was pressed down upon it; and on the hinder limb being withdrawn, its cuticle was left inverted under the arm, and that of the anterior extremity was now loosened, and at length drawn off by the assistance of the mouth. The whole cuticle was thus detached, and was now pushed by the two hands into the mouth in a little ball, and swallowed at a single gulp.' The common snake (*Coluber Natrix*) when in confinement moults as follows: The formation of the new cuticle produces a detachment of the old from the subjacent living parts, and the latter then loses part of its transparency and smoothness. As the cuticle is continued over the cornea, the sight of the serpent is dimmed; its motions are also in some degree cramped, and it endeavours to free itself of its encumbrance by rubbing the sides of its mouth against any rough and hard resisting substance. The old cuticle is thereby detached from the circumference of the mouth, and is turned back over the head; and the impediment to vision being thus removed, the snake proceeds with more vigour and rapidity to detach and turn back the cuticle, by repeating the same actions as those with which it commenced the operation; and at length it literally creeps out of its skin, which is left inverted, and more or less entire, according to the degree of the animal's health and vigour at the time of the operation. The rattlesnake is described as actually inverting and drawing off its own skin. After having rubbed back the cuticle from the head, it throws the posterior part of the body in numerous coils around the anterior; one coil is placed in front of the detached part of the integument; and compressing the body strongly, it pushes forward the head and neck, gradually unfolding the coils behind, and stripping off the skin, as it advances forwards. In the warm-blooded classes the periodically moulted feathers of birds, and hairs of various species of Mammalia, may be regarded as exuvial deposits; as also the small scales of the scarf-skin which are incessantly cast off in man.

Eye (A.-Sax. eage, Ger. auge, Lat. oculus). In describing the structure of the organ of vision, anatomists generally refer to external and internal parts: the former include the eyebrows, or *supercilia*; the eyelashes, or *cilia*; and the eyelids, or *palpebræ*. The cartilaginous edge of the eyelids is called the *tarsus*, in which, as in the inner surface of the eyelids, are small glands which secrete a lubricating serous fluid, called, after their discoverer, the glands of Meibomius. Near the external corner or *canthus* of the eye, and in a depression of the frontal bone, are the lachrymal glands (*glandulæ lachrymales*), which secrete tears; their ducts open on the inner surface of the upper eyelid. The little projection at the inner angle of the eye is called the *lachrymal caruncle*. There are also two small orifices observable at the inner angle, one in the upper and one in the lower eyelid, which are called the *puncta lachrymalia*; they convey the tears by means of two small tubes to the *lachrymal sac*, whence they pass by the *nasal duct*, which opens under the inferior spongy bone, into the nose. The conjunctive membrane of the eye, called also *tunica albuginea*, or white of the eye, is a membrane which lines the inner eyelids and the fore part of the globe of the eye. The internal parts of the eye are: the *sclerotic membrane*, which is the hard outer case of the globe; the *choroid membrane*, which is the interior coat of the sclerotic, beginning around the optic nerve, and proceeding to the margin of the transparent cornea, where it deflects inwardly, forming the *iris*, the posterior surface of which is called the *uvea*, and its central opening the *pupil*, which is muscular, admitting of dilatations and contractions so as to modify the quantity of light admitted into the inner chambers of the eye. The *crystalline lens* is a pellucid body included in a delicate *capsule*, and lodged in a concave depression of the front of the *vitreous humour*, which is a transparent and pellucid pulpy texture, filling the ball of the eye behind the lens, and covered externally by the *hyaloid* or *arachnoid* membrane. The optic nerve enters the back of the eyeball by a perforation in the sclerotic and choroid coats, and is spread upon the posterior and inner surface of the latter, forming a pulpy film or nervous matter called the *retina*. The eye is moved by six appropriate muscles. In the annexed cut, representing a section of the ball of the eye, *a* is the sclerotic membrane or coat, *b* the iris, *c* the retina, *d* the optic nerve, *e* the vitreous humour, and *f* the crystalline lens. [VISION.]



Eye Agate. The name given to those kinds of circle agate, the central parts of which are of deeper tints than the rest of the mass.

The term *eye agate* is also applied to stalactitic carbonate of lime, when sections made at right angles to the axis display a darker coloured spot in the centre, presenting a fanciful resemblance to the pupil of the eye.

Eye of a Dome. In Architecture, the circular aperture in the summit through which light is admitted.

Eye Stone. A small calcareous stone found in the shells of some mollusca, and formerly used for removing substances from between the lid and the ball of the eye.

Eye of a Volute. In Architecture, the circle in its centre.

Eye-bolt. On Shipboard, a pointed iron bar with a hole at the thick end. It is intended to be driven into one of the timbers, and then to have a rope passed through the hole.

Eye-piece. An eye-piece, or *power* as it is sometimes called, is the lens or combination of lenses used in microscopes or telescopes to examine the aërial image formed at the focus of the object-glass. The ordinary eye-piece is a combination, and may be either *positive* or *negative*. The former consists of two plano-convex lenses, with their convex sides towards each other; and is used for micrometers. The negative or Huygenian consists of the same lenses with the convex sides turned away from the eye. Besides these there are in use, for observations of the sun, a *diagonal eye-piece*, in which a very small percentage of the sun's light and heat is reflected from the first surface of a prism, the rest being transmitted; and *Dawe's solar eye-piece*, in which the light is reduced by observing only an extremely minute portion of the solar surface. Steinheil and Kellner have also contrived eye-pieces; they, however, are not in such general use. The eye-piece of opera-glasses consists of a combination of biconcave lenses—an arrangement which is almost out of date as applied to telescopes, although occasionally it may be used with advantage.

All these eye-pieces except the last mentioned invert. The *terrestrial* or *erecting eye-piece* is a combination of four lenses, used for terrestrial telescopes.

In eye-pieces, as in object-glasses, the optician has to get rid of spherical and chromatic aberrations: it is also a sine quâ non that the field of view shall be flat. Those who wish for more information on this subject should refer to exhaustive memoirs by Mr. Airy (*Cambridge Phil. Trans.* vols. ii. and iii.), or a paper by Biot (*Mémoires de l'Institut*, 1843).

Eye-teeth. The two upper cuspidati are so called in consequence of the length and direction of their fangs, which extend upwards nearly to the orbit of the eye.

Eyebright. [EUPHRASIA.]

Eyre. In old English Law, signified the court of justices itinerant. The term is in all probability derived from the Lat. iter, *journey*; as Bracton styles the justices who presided in these courts *justiciarii itinerantes*.

F

F. The sixth letter of the English and Latin alphabets; a labiodental aspirate, bearing the same relation to the other labiodental aspirate, V, which the letters called *tenues*, *p*, *k*, *t*, bear to the *mediæ*, *b*, *g*, *d*. It corresponds with the DIGAMMA [which see] of the Æolian dialect, to which it is closely related both in form and power; and is susceptible of a few interchanges, chiefly in the Spanish and Latin languages.

F. In Music, a note of the scale, corresponding with the *fa* of the French.

Fa. In Music, one of the syllables invented by Guido Aretino to mark the fourth sound of the modern scale of music; rising thus: *ut*, *re*, *mi*, *fa*. It is now used by the French and Italians to designate our note F.

Faba (Lat. *a bean*). A genus of Leguminous plants, comprising the common annual Bean, *F. vulgaris*, a vegetable supposed to have been originally derived from the shores of the Caspian. As an esculent, the parts eaten are the young seeds, which are very nutritious. Beans are also cultivated as a farm crop, the varieties being different from those grown in gardens. They are used in a bruised state as food for horses, and ground into meal for fattening pigs, &c. *Kidney beans* are the produce of a species of *Phaseolus*.

Fabaceæ. [LEGUMINOSÆ.]

Fable (Lat. fabula). In Literature, a term applied originally to every fictitious tale; but confined in modern usage to a class of tales, either in prose or verse, which inculcate a moral precept through the medium of a short fictitious story. In the very ancient Indian Fables of Pilpay, the Arabian of Lockman, and the Greek of Æsop, the fictitious personages introduced are chiefly animals, endued for the purpose of the story with human faculties and language; and hence modern fabulists have generally introduced similar agents in the greater number of their fables. In this sense, the fable is synonymous with *apologue*, and belongs to the class allegory. Fables are either in prose or verse; but if the latter, they will not bear with propriety a highly poetical or ornamental character. Herder has divided

fables, according to the character of their meaning, into three classes: 1. Theoretic, intended to form or exercise the understanding; 2. Moral, which contain rules for the regulation of the will; 3. Fables of fate or destiny, in which the narrative contains no maxim of self-conduct, as it merely represents a series of contingencies brought on by necessary connection. But it may be doubtful whether every fable, in the sense in which the name is generally used, does not belong properly to the second class; the instances cited by Herder as appertaining to the first and third were certainly intended by the inventors to bear a moral meaning.

Fabliaux (Fr.). In French literature, the metrical tales of the Trouvères or early poets of the Langue d'Oil, or dialect of the north of France; composed, for the most part, in the twelfth and thirteenth centuries.

Fac. In Printing. The name *fac* (facsimile) was given by the early printers to the large ornamental letter used at the commencement of a division of a book.

The first books were printed in imitation of, and sold as, MSS.; and the printers left a blank space at the beginning of books, chapters, &c., for an illuminator to fill in the proper letters, with appropriate ornaments in gold, silver, and colours. When printing became no longer a secret, and the deception could not be continued, ornamental letters of a large size were introduced, and printed with two colours, generally red and blue, the letter being of one colour, and the flourishes (extending the whole length of the page) in the other, so as to have the appearance of being done with a pen. Then succeeded various grotesque figures, to resemble letters, and afterwards small capital letters, with ornaments round them, forming a square design. Subsequently the block was pierced so that any letter could be introduced, and the ornamental part used for any initial; and the next plan was for the type-founders to cast the letters in type-metal, and pierce them for general use. Lastly, we have what is called a *two-line letter*, a large type extending to the depth of two or more lines, the modern representative of the beautiful coloured initials of the illuminati.

Fac-simile (Lat. *make-like*). This term, expressed in French by the words *fais-semblable*, signifies an exact and faithful copy of any writing, engraving, or other work of art.

Façade (Fr.). In Architecture, the face, or front, of any building towards a street, court, garden, or other place, is called the *façade*; but the term is more commonly applied to the principal elevation of the building to which it is desired to direct attention.

Face (Lat. facies). In Fortification, one of the sides forming the salient angle of a ravelin or bastion.

Face. In Solid Geometry, any one of the planes which form the surface of a polyhedron.

Facet (Fr. facette). A lapidary's term for the small plane surfaces cut on precious stones to reflect the light, and so to increase their lustre.

Facial Angle. [Angle, Facial.]

Facients (Lat. faciens, part. of facio, *I make*). In modern Algebra, the variables of a quantic as distinguished from the coefficients. (Cayley 'On Quantics,' *Phil. Trans.* 1854.)

Facies Hippocratica (Lat.). The peculiar expression of countenance which indicates the approach of death; it has been accurately described by Hippocrates, whence the above common medical term.

Facing. In Architecture, this term is generally employed to mean the better description of material which serves to mask an inferior one, as when stone facing is used upon brickwork, &c.

Faction (Lat. factio). By the ancient Romans this appellation was given to the different troops or companies of combatants in the games of the circus. Of these factions there were four—the green, blue, red, and white; to which two others were said to have been added by the emperor Domitian—the purple and the yellow. In the time of Justinian 40,000 persons were killed in a contest between two of these factions; and they were at last suppressed by universal consent. The term *faction* is applied also, in a more general sense, to any party in a state which attempts without adequate motives to disturb the public repose, or to assail the measures of government with uncompromising opposition. In the ancient Greek republics, faction was carried to an extent unparalleled in modern times. The middle ages were distinguished chiefly by two factions, the Guelphs and Ghibelins, who long kept Italy in a state of alarm. In England, the term *faction* was long bandied about between the three great parties of the country, the Whigs, Tories, and Radicals, being applied indiscriminately by the adherents of one party to those of the other. [Party.]

Factor (Lat.). In Arithmetic and Algebra, the name given to each of the quantities which we multiply into one another in order to form (*facere*) a product. The factors of a number are its several *divisors* or *measures*.

Factor. In Mercantile Law, a mercantile agent, who is intrusted with the possession of the property which he is commissioned to dispose of. Under the law which obtained previously to the passing of the Act 6 Geo. IV. c. 94, it was held that a factor, as such, had authority to sell only, and not to pledge, the goods of his principal; and, consequently, that a party who had made a bonâ fide advance to the factor on the credit of the goods was liable to restore them to the principal without his being bound to repay the advance. By that statute it is enacted, that any person intrusted, for the purpose of consignment or sale, with goods, &c., and in whose name such shall have been shipped, shall be deemed the true owner, so far as to entitle the consignee to a lien thereon in respect of any money or negotiable security advanced by such

consignee for the use of the person in whose name such goods, &c. shall have been shipped: provided the consignee has no notice, by bill of lading *or otherwise*, that such party is not the true owner. Various other provisions are added by the same Act, to the effect that persons in possession of bills of lading shall be deemed owners, so far as to make valid contracts; that no person can acquire a security upon goods in the hands of an agent for an antecedent debt beyond the amount of the agent's interest in the goods; that persons may contract with known agents in the ordinary course of business, or out of that course, if within the agent's authority; that persons may accept and take goods in pledge from known agents; and a right is preserved to the true owner to follow his goods, while in the hands of his agent or the agent's assignee, in case of the bankruptcy of such agent or assignee. A factor has a general lien on goods consigned to him, not only for incidental charges, but as an item of mutual account for the balance due to him, as long as he remains in possession.

In Scotland, the term *factor* is used synonymously with *steward* in England; it is also the title of an officer, who may be appointed by parties to act as *attorney* in English law, or by the courts (judicial factor) to take charge of the estate of a minor or absent person, &c.; now regulated by 12 & 13 Vict. c. 51.

Factor, Integrating. [INTEGRATING FACTOR.]

Factorials. A name given to the factors of a continued product when the former are derivable from one and the same function $F(x)$ by successively imparting a constant increment or decrement h to the independent variable. Thus the product

$$F(x) \,.\, F(x+h) \,.\, F(x+2h) \ldots F[x+(n-1)h]$$

is called a *factorial term*, and its several factors take the name of *factorials*. The symbols $x^{(m)}$ and $x^{(-m)}$ are frequently employed to denote, respectively, the factorial terms

$$x(x-1)\ldots(x-m+1),$$

and
$$\frac{1}{x(x+1)\ldots(x+m-1)}.$$

Factory (Lat. factor, *a maker*). The earliest usage of this term was to signify a dépôt for goods. In this sense the settlements of the East India Company were called *factories*. Gradually, however, the word has been limited to establishments in which certain commodities are manufactured, as cotton and woollen stuffs, and hardware generally.

Reports of the wretched condition of workpeople in factories and collieries, and evidence collected before parliamentary committees, led to the framing of factory Acts for the supervision of these establishments. The legislation was resisted partly on the ground of its being a mischievous interference between employer and employed, partly because it was onesided in its operation. The last objection was unquestionably the most important. In general, factory Acts involve the nomination of an inspector, to whom a district is assigned, and secure that persons of tender years shall not be employed at all, and that others older, but still below a certain age, shall only be employed at half time, provision being made for the education of children. In some cases provisions are made against the employment of women.

In practice it has been found that these limitations have been politic, however little we may believe that policy led to the enactment of the factory laws. Experience has shown that a limitation of the hours of labour, especially in the case of young persons, is followed by greater effectiveness in the labour afforded; and, on the whole, the manufacturer has been rather benefited than injured by the restrictions. But what applies to one class of employment, applies to all equally; and if supervision and limitation are desirable in the case of juvenile and female labour in certain establishments, they must be so in others, whether in town or country. There cannot be the smallest reason why the labour of children should be prohibited in large and well-ventilated factories, and permitted in agriculture—why women should be protected in a colliery, and worked to death in a slopshop.

The chief authority on factory regulations and similar sanitary measures is Mr. Edwin Chadwick, whose writings on the subject may be examined with advantage. [TRUCK SYSTEM.]

Faculae (Lat. dim. of fax, *a torch*). In Astronomy, those portions of the sun's disc which appear brighter than the rest of his surface. Recent investigations, and an examination of the Kew sun pictures, render it probable that these are the highest portions of the sun's cloudy photosphere. [SUN.]

Faculty (Lat. facultas). In Ecclesiastical Law, a license or authority to do or enjoy a certain thing, as the right to a pew, or monument, or particular mode of burial. The grant of faculties is a jurisdiction belonging to the archbishop. [ECCLESIASTICAL COURTS.]

FACULTY. In the Universities. In the origin of the university of Paris (which is considered as the model of all European institutions in the middle ages) the seven liberal arts (grammar, logic, rhetoric, arithmetic, geometry, astronomy, and music) seem to have been the subjects of academic instruction. These constituted what was afterwards designated the Faculty of Arts. Three other faculties—those of divinity, law, and medicine—were subsequently added. In all these, lectures were given, and degrees conferred by the university. The four faculties were transplanted to Oxford and Cambridge, where they are still retained; although, in point of fact, the faculty of arts is the only one in which substantial instruction is communicated in the academical course. By an anomaly of ancient date, the English universities also give degrees in what is not properly a faculty, but only a branch of one of the faculties, viz. music. On the Continent, the faculty of arts is

synonymous with that of philosophy. In England, that of divinity is not wholly distinct from, but superior to, that of arts; degrees in the latter being preliminary qualifications for those in the former.

Faculty, Dean of. In Scotland, the elective president of the faculty of advocates, answering to barristers in England.

Fæces (Lat.). The excrements; usually confined, in Physiology, to the solid matter evacuated from the alimentary canal. According to the analysis of Berzelius, human fæces of consistence sufficient to form a coherent mass are composed of:—

Water			75·3
Matters soluble in water	Bile	0·9	5·7
	Albumen	0·9	
	Peculiar extractive	2·7	
	Salts	1·2	
Insoluble residue of the food			7·0
Insoluble matters which are added in the intestinal canal—mucus, biliary resin, fat, and a peculiar animal matter			14·0
			102·0

The influence of various foods upon the composition of excrement has been experimented upon by Dr. Marcet, *Philosophical Transactions*, 1861. [EXCREMENT.]

Fæcula or **Fecula** (Lat. dim. of fæx, *a sediment*). When certain vegetable products are bruised and mixed with water, the pulverulent matter which subsides is called the *fecula* or *fæces*; it is commonly of a starchy nature, hence starch is often called *fecula*. [STARCH.]

Fagging. [PUBLIC SCHOOLS.]

Fagine. A crystalline alkaloid found in beech-nut (*Fagus sylvatica*).

Fagopyrum (Gr. φηγός, Lat. fagus, and πυρός, *wheat*). The genus of the Buckwheat, *F. esculentum*, sometimes known as *Polygonum Fagopyrum*. It is a native of Central Asia, but has been so long cultivated as to have become naturalised in many parts of Europe. In this country, it is chiefly grown for the purpose of affording food for pheasants.

Fagus (Lat.). The Beech-tree of our woods, *F. sylvatica*, is the principal member of this genus of *Corylaceæ*. It is a native of Europe and Asia, and forms a large handsome tree, especially when growing on chalky hills. Its timber, though not of the first quality, is useful for many purposes, and it is also one of the most useful kinds of wood for fuel. The three-cornered nuts are edible, and much sought after by swine, and an oil is expressed from them. In gardens, the Purple and Copper leaved varieties are trees of great beauty.

'*Phegos*, in Greek, means oak, never beech: in Latin and Gothic, *fagus* and *bôka* signify beech, and beech only.' In the same way, the Latin *quercus*, which signifies only oak, represents the Teutonic word *fir*. These singular changes in the meaning of the same words are probably to be explained by the change of vegetation which took place since the arrival of the Greek, Latin, and German races in their European homes. Similar changes, going on in words at the present day, explain the fact that the Greek *phegos* retained its old meaning, while the Italian and Teutonic Aryans applied the word to the new beechen forests which were springing up around them. (Max Müller, *Lectures on Language*, second series.)

Fahlerz (Ger.). A mineralogical synonym of Grey Copper Ore.

Fahlunite. A mineral, from *Fahlun*. in Sweden. It is a hydrated silicate of alumina.

Faience (from Faenza, the original place of manufacture). In the Fine Arts, pottery, consisting of a common earthenware ground, covered with a glaze, and enamelled with painted designs. It is also called *Raphael ware*, because Raphael was thought in his early days to have been engaged on this department of the art: but this is a vulgar error; the Raphael who was employed in painting pottery was a Raffaello Ciarla of Urbino, who lived in the middle of the sixteenth century. Although it is true that many of Raphael's designs have been painted on pottery, none were so painted during his lifetime.

Fainting. [SYNCOPE.]

Faints. The impure and weak spirit constituting the last runnings of the still, used in the manufacture of alcohol.

Fair (Fr. foire). A meeting held at stated times of the year in particular places, for the purposes of traffic, to which merchants resort with their wares. Fairs, in Christian countries, were usually held on particular festivals; and are so still in England, unless where they have been fixed to particular days in the month by later grants of privileges. By the English law, the king's authority only is supposed to confer the privilege of holding a fair, with the court of pie-powder to determine disputes arising there. Fairs are considered free, unless toll is due to the owners by special grant, or by custom, which supposes such grant.

Fairies (Fr. fée, *a fairy*: féerie, *witchery*; Ital. fata, *a fairy* or *witch*, from Lat. fatum, *fate*). Imaginary beings, in the traditional mythology of the nations of Western Europe, and especially in these islands. The resemblance of their English name to that of the Peris of the Persians (pronounced Feri by the Arabians) seems to be merely accidental. The British fairies, although they have something in common with the Dwergas or Gnomes of the Scandinavian mythology, are not identical with them; they are in fact peculiar to people of Celtic race, and the notions respecting them prevalent among the Celtic population in Scotland, Wales, and Ireland tally to a remarkable degree. The popular belief, however, was nowhere invested with so poetical a character as in the Lowlands of Scotland, where it forms a main ingredient in the beautiful ballad poetry of the district. The fairies of the Scottish and English mythology are diminutive beings, who render themselves occasionally visible to men, especially in exposed places, on the sides

of hills, or in the glades of forests. They have also dealings with men, but of an uncertain and unreal character. Their presents, though sometimes valuable, are generally accompanied with some condition or peculiarity which renders them mischievous: more often they turn into dirt or ashes in the hands of those to whom they have been given. Mortals have been occasionally transported into Fairy-land, as in the legend of Thomas the Rhymer. The popular belief in fairies has been made the subject of poetical amplification in the hands of so many of our greatest writers, from Shakspeare to Scott, that it is not easy to disentangle embellishments from the original notions on which they are founded. The Fata of the Italians, who figures in their romantic epics, and from whom the French have made the Fée of their fairy tales, is a female magician, sometimes benevolent and sometimes malevolent, having a supernatural character, and gifted with the spirit of prophecy. Such is the Fata Morgana, to whom the celebrated optical delusion occasionally produced in the straits of Messina was formerly attributed by popular belief.

Fairy Rings. The green circles or parts of circles sometimes seen in pastures. They are produced by certain Fungi, chiefly species of *Agaricus*, in this way: A patch of spawn spreads in every direction, and produces at its edge a crop of its particular fungus; the spawn exhausts the inner portion of soil, so that the spawn there dies, but the crop of fungi meanwhile perishes, and supplies a rich manure to the grass, which in consequence becomes of a vivid green. The spawn progresses outwards, and the process of exhaustion and renewal goes on, so that the ring increases in diameter year after year, till it is sometimes several yards across. *Agaricus oreades*, *gambosus*, and *arvensis* are some of the principal species which give rise to these mysterious-looking rings. The reader is referred to a paper on this subject, by Dr. Wollaston, in the *Philosophical Transactions* for 1807, p. 133.

Faith (Lat. fides). In Theology. It is observable that the writers of the New Testament employ one and the same word for faith and belief. In most modern languages, the use of two different terms has, perhaps, strengthened the feeling of a difference between the conviction of the heart and that of the understanding: the German, like the Greek, has one only. Faith, in the language of the Epistle to the Hebrews, is 'the substance of things hoped for, the evidence of things not seen.' Perhaps these expressions might be more accurately rendered 'confidence' in things hoped for (compare 2 Cor. ix. 4; xi. 17), 'conviction' of things not seen (Heb. xi. 1). Through this faith, it is declared that men receive as true things delivered to them on divine authority, to which neither their senses nor their uninstructed reason bear testimony, and endure sufferings and do great actions for God's sake, while without it 'it is impossible to please Him.' Such faith 'was imputed' to Abraham 'for righteousness' (Rom. iv. 21); and thus 'being justified by faith, we have peace with God through Jesus Christ.' (Rom. v. 1.) It is evident from these as well as many other passages in the Apostolic Epistles, that this justification is spoken of as attained only by that faith which obeys the command as well as relies on the promise of God; termed by theologians *efficacious* or *saving* faith.

Fake of a Cable or Rope. In Nautical language, this term is applied to any one of the circles formed by a cable or rope, as it lies in a coil.

Fakir. An Arabic word signifying *poor*: applied in some Eastern countries to a sect of enthusiasts, who retire from the world and devote themselves to religious observances. They are chiefly remarkable for their assiduity in 'mortifying the flesh,' considering no infliction of the body as too severe, provided they can inspire the observer with reverence towards them. There are, however, some classes of Fakirs distinguished for good sense, learning, and piety.

Falcate (Lat. falcatus, *sickle-shaped*). In Botany and Zoology, when any part is curved with an acute apex.

Falcated (Lat. falx). The moon is said to be *falcated* when her illuminated part appears in the form of a crescent or sickle, which happens when she is in the first and fourth quarters.

Falchion (Fr. fauchon, Lat. falx). A sword in use in the thirteenth century, with a broad blade, widening towards the point, the edge convex.

Falciform Process of the Brain (Lat. falx). A process of the *dura mater*, which arises from the *crista galli* and terminates in the *tentorium*, separating the hemispheres of the brain.

Falco (Lat. *a falcon*). The name of a Linnæan genus of Accipitrine Diurnal birds, characterised by a beak crooked, and covered with a cere at the base; head closely invested with feathers. To the short Linnæan phrase descriptive of this group of birds of prey may be added, that the supraciliary arch projects above the eye, giving a bold and threatening physiognomy to these rapacious birds, the majority of which subsist on living prey. The first plumage differs from that of maturity, which is not acquired before the third or fourth year. The female is generally one-third larger than the male. The Linnæan genus is now subdivided into the subgenera *Falco*, Bechstein; *Hierofalco*, Cuv.; *Aquila*, Brisson; *Haliætus*, Savigny; *Pandion*, Sav.; *Circætus*, Vieillot; *Harpyia*, Cuv.; *Morphnus*, Cuv.; *Astur*, Bechstein; *Nisus*, Cuv.; *Milvus*, Bechstein; *Pernis*, Cuv.; *Buteo*, Bechstein; *Circus*, Bech.; *Gypogeranus*, Illig. Of these subgenera, the first two form what are termed the *noble* birds of prey, and they are the most courageous in proportion to their bulk. This quality is associated with a powerful form of the beak, of which the arch commences from the base, and which is armed with a strong tooth on each side near

the apex. Their wings are strong, long, and pointed, the second quill-feather being the longest. It is from this division of falcons that the birds are selected for the sport of falconry. In the *ignoble* division of the birds of prey, the longest quill-feather of the wing is almost always the fourth, and the first is very short, which gives the wing an appearance of having the extremity obliquely truncated. The bill is not armed with lateral tooth-like processes.

Falconines, Falconinae (Lat. falco). A subfamily of Accipitrine birds, having the genus *Falco* proper as the type; and characterised by a beak short, hooked from its base, and toothed near the apex; wings long, second quill shortest. It includes the genera *Ferax* and *Faloo.* The term *Falconidæ* is used by some ornithologists in a sense as extended as DIURNÆ [which see].

Falconry. The origin of this celebrated sport has given occasion to much controversy. It has been said that it was unknown to the Greeks; it is, however, described by Ctesias and Aristotle as practised in their time in India and Thrace. Martial and Apuleius present us with plain indications of the knowledge of this pastime among the Romans. In modern Europe, it appears to have been practised earliest, or at least with most ardour, in Germany: the title of the emperor, Henry the Fowler (A.D. 920), is said to be derived from an anecdote respecting his fondness for it. In the twelfth century, it was the favourite sport of nobles and knights throughout Europe; and in the thirteenth its rules were reduced into a system by the emperor Frederick II., and by Demetrius, physician to the Greek emperor Palæologus. In that court the grand falconer was an officer of distinction; and the title was borrowed from it by the Western sovereigns. According to the opinion of Strutt, the sport was not known so early in England as on the Continent; yet there are traces of it as early as the eighth century. From the commencement of the seventeenth, we may date its gradual decline. James I., devoted to hunting, was no admirer of falconry, which up to his time had been the favourite royal sport. But its final abandonment, except as the fancy of a few individuals, was owing to the gradual improvement in firearms presenting far easier methods of obtaining game. Among the many curious works which exist on this subject, once so universally interesting, may be mentioned the treatise *De la Fauconnerie* of Charles d'Espernon, Paris 1605; the celebrated *Book of St. Albans*, by the Prioress Juliana Berners, 1486; Latham *On Falconry*, 1658; Ray's *Idea of Falconry*, published with Willoughby's *Ornithology*. The emperor Frederick II. did not disdain to give the world the results of his experience in the art, in a treatise published in 1596 from his MS., under the title *Reliqua Librorum Frederici II. Imp. de Arte Venandi cum Avibus.*

Falculate (Lat. falcula, dim. of falx, *a sickle*). In Zoology, a claw is so called when it is compressed, elongate, curved, and sharp-pointed.

Fall. The Sea term for that rope of any pulley or system of pulleys to which the pressure or moving power is applied. To *fall aboard* signifies to run foul of another vessel.

FALL. A Scotch measure of length and surface, the former being equal to six Scots ells, or 6·1764 English yards; and the latter being equal to 36 square ells.

Fallacy (Lat. fallacia, from fallo, *I deceive*). In Logic and Rhetoric, any argument, or apparent argument, which professes to be decisive of the matter at issue, while in reality it is not. Fallacies have been divided into those *in dictione*, in the words; and *extra dictionem*, in the matter. The latter of these it is not the province of logic to discover and refute; they being, strictly, instances in which the conclusion follows from the premisses, and which therefore depend on the unsoundness of these premisses themselves, which can only be detected by a knowledge of the subject-matter of the argument. Logical fallacies, or fallacies in dictione, are those in which the conclusion appears to follow, but in reality does not, from the premisses; and which, consequently, can be detected by one unlearned in the subject-matter of the argument, but acquainted with the rules of logic. These are subdivided, however, into fallacies purely logical, i.e. vicious syllogisms [SYLLOGISM; PARALOGISM], and fallacies semi-logical, those namely which arise from the employment of a middle term in argument [SYLLOGISM; PROPOSITION; MIDDLE TERM] ambiguous in sense. In rhetoric, a common set of artifices, by which the mind of the reader or hearer is diverted from the question at issue and fixed on some collateral topic, are termed *fallacies*; as, where the character of the proposer of a measure is discussed as a reason for or against the measure itself, &c. &c.

Falling Home. The term applied to the timbers or upper parts of the sides of a ship when they curve inwards. The old ships fell home, or tumbled in (as it is also called), much more than the modern ones, which approach more nearly to being *wall-sided.*

Falling Sickness. [EPILEPSY.]

Falling Stars. [SHOOTING STARS.]

Fallopian Tube. The name given to a canal or tube, discovered by Fallopius, arising at each side of the fundus of the uterus, and terminating in the ovarium.

Fallow (possibly connected with Scotch, fail, *a sod* or *turf*, Swed. vall, *sward*: Wedgwood). In Agriculture, lands are said to be under fallow when under cultivation whether with or without a crop. A naked fallow is one in which the soil remains a whole year without any crop whatever; and a turnip or green crop fallow is one in which the lands, after being without a crop from harvest till the beginning of the following summer, and being properly laboured during that period, are sown with turnips or other similar crops in rows, and the ground cultivated in the intervals. Fallowing was practised by the Romans on all soils, and

has been continued through the dark ages, in all tho cultivated parts of Europe, so as to have become, till lately, a general habit in the treatment of arable lands. The practice of taking two corn crops, and then allowing the land to rest or lie fallow, was till the commencement of the present century prevalent throughout Europe; and it is still a very common practice in most parts of the Continent. It appears to have been first broken through by the Flemings about the end of the sixteenth century; and subsequently in Britain, with the culture of turnips, above a century and a half later. Bare fallows, under the most improved systems of agriculture, are no longer had recourse to in the case of free or easily worked soils, where turnip fallows are made, or drill crops of legumes are substituted; but in very strong clays they are still found necessary, and this will probably continue to be the case till by thorough drainage, and perhaps steam culture, the strong clays become friable and fit for the drill husbandry, like the sandy loams and other free soils.

Fallow Deer. The *Cervus Dama* of Linnæus. It has nearly superseded the old English Red Deer in the British parks. Its introduction from the south of Europe was effected during historical times; but a fossil species, apparently indistinguishable from the recent one, existed in the post-pliocene age. [Deer.]

False Cadence. In Music, one wherein the bass rises a tone or semitone, instead of rising a fourth or falling a fifth.

False Keel. The timber added below the main keel, to serve as a defence in case of grounding; also, by deepening the vertical plane, to enable the ship to take a better hold on the water, and therefore to carry sail with greater ease.

False Pretences, Obtaining Property by. In Law, is distinguished from *larceny* as being perpetrated through the medium of mere fraud. At common law it is a misdemeanour; but for the purposes of justice the distinction between the two offences is now rendered by statute practically unimportant.

Falsetto (Ital.). In Music, that part of a person's voice which lies above its natural compass, and is produced to various extents in different subjects, male as well as female. It rarely extends more than four or five notes above the natural voice, and is produced by diminishing the aperture of the throat.

Faluns. In Geology, a name given to the low cliffs on the Loire and other French rivers, and thence applied as a geological name owing to the occurrence in these cliffs of large and interesting series of fossils of a definite geological period. The Faluns of Touraine are typical of the *miocene* or middle tertiary period. The name *falun* seems to belong especially to certain banks of shelly gravel, such as in Suffolk are called *crag*, extending at intervals from Dinan in Brittany to the Loire. They are very rich in fossil shells.

Fama (Lat.). The Latin personification of Rumour. (Virg. *Æn.* iv. 174.) In Homer it was represented under the name *Ossa.* (*Od.* xxiv. 413.)

Familia (Lat.). In Roman Antiquities, a house or family, being a subdivision of *gens* or clan. [Gens.] Its members were distinguished by using the same *cognomen*, the family name. The word was also employed to denote all that was subjected to the will of one man, whether free persons or slaves, or material property, and was sometimes limited to the slaves of a household.

Familiar or **Familiar Spirit.** Familiar spirits are spoken of in the Mosaic laws; and the First Book of Samuel mentions the familiar spirit of the witch of Endor. The genius or δαιμόνιον, which Socrates and some other celebrated ancients were said to have possessed as a companion, was a species of *familiar.* In modern Europe and Asia, the belief in familiar spirits forms an important feature in the widely spread superstition respecting the magical art. The subject is curiously examined in the article in the *Encyclopædia Metropolitana.*

Family (Lat. familia). In Zoology, the group next in value and comprehensiveness above the genus. The term is synonymous with *genus* in the classification of Linnæus, who indicated the different groups of species therein comprehended by numbers instead of collective appellations.

Such divisions of the Linnæan genus occur only in those instances in which an unusual number of species presented themselves to the consideration of the clear-sighted Swede. The progress of modern discovery has added so many new forms to the naturalist's catalogue as to render necessary a corresponding subdivision of most of the Linnæan genera. To these subordinate groups of species distinct names are given, for the sake of convenience; and in order to designate the natural family which these groups compose, the name of the original or typical genus is generally retained with the addition of the Greek patronymic *idæ* to the genitive case. Thus e. g. the characters of the Linnæan genus *Mus* are applicable to a vast number of Rodents, which scientific precision requires to be arranged in numerous subordinate groups; these are distinguished by appropriate generic names in modern systems, and the term *Muridæ* is applied to the *family* which they collectively compose.

Family Council (Conseil de Famille). According to the law of France (Code Napoléon), is composed of six relations, designated by the law, of a minor possessing property, together with the juge de paix. Its peculiar function is the selection of a guardian (tuteur) where none has been appointed by paternal or other legal authority. But it has also the right to dismiss a guardian for misfeasance; to sanction the sale of property of the minor; and other very important powers in relation to his management, and the control of his affairs. Some of its acts require confirmation by the tribunals: others are absolute.

Famine (Fr. from Lat. fames, *hunger*). When a scarcity of the means of subsistence is so considerable that food is not procurable even by the omission of all other expenditure, famine ensues, and the poorest and most weakly part of the population is sacrificed.

Famines are epidemic in the East. The art of agriculture is imperfect, and the people, generally speaking, living on the cheapest food, and having no export trade of importance, are almost always close upon the margin of possible subsistence. The occurrence of a famine reduces the numbers, and distributing what remains among fewer persons, leaves them the means of life. It is no doubt due to the physiological fact that epidemic disorders of a novel and destructive kind are generated among peoples liable to periodical famines, that the smallpox, the black death or Oriental plague, and the cholera have travelled from the East westwards at different periods.

In England, the latest examples of actual famine occurred in the years 1316, 1317, and 1321. The reason why this country has never been visited by famine for centuries, though often by scarcity, resides in the fact that the habitual food of the English people has been, from the very earliest times in which records of agriculture have been preserved, wheat, the most expensive of all cereals in its cost of production. This fact can be proved by incontestable evidence. Now, where the habit of a people induces the use of a costly kind of food, it is always possible, on the occurrence of scarcity, to substitute a cheaper for the dearer commodity. Population, in short, though it may increase up to the means of subsistence, never increases beyond it; and the limit of population is found in the cost of procuring, in ordinary or average years, the kind of food upon which the people regularly subsist. If, on the other hand, the people are content with the cheapest kind of food, they are always in danger of actual starvation by famine. The Irish famine of 1845 was by no means the only example of such a social calamity, though by far the most appalling for its dimensions and its consequences. Its occurrence is to be fairly ascribed to the practice of subsisting wholly upon the potato, a cumbrous kind of food, carried with difficulty, and capable of being stored only for a very short time; and of course, as supplies from foreign countries can be procured only by acts of exchange, a people which resolves to live on such a food may and does starve in the midst of the plenty enjoyed by other communities.

This economical law, that the risk of famine or the contingency of over-population is in inverse ratio to the charge at which the habitual food of the people may be obtained, has been too much neglected by economists. When the food is costly, the risk is remote; when it is cheaply procured, the danger is near. Hence, much of the reasoning upon over-population and its remedies is vicious, because it omits the consideration of the important questions, What is the habitual food of the people? and what proportion does the cost of its production bear to the charge at which other kinds of food, available during the pressure of a scarcity, may be obtained?

In the same way, the risk of famine, and even scarcity, is obviated by a wide market. It is clear, in the first place, that the kind of food which costs most to procure at home, and which can nevertheless be grown over a wide area abroad, will, by commanding a better price, be supplied in fuller measure. Hence we may reasonably predict that, though a rise in the price of barley and oats is intelligible, any scarcity in the price of wheat on the hypothesis of free trade is highly problematical. In the next place, the wider the area, the more is the variation in seasons obviated. A bad harvest in one locality is met by a good harvest in another, just as a drought in one region is counterpoised by an increased rainfall in another. In short, the imports and exports of nature, to use an economical parallel, balance one another. The energies, too, of mankind, especially of the Anglo-Saxon race, are yearly making the contingency of even scarcity exceedingly remote. Wheat is imported into this country at highly remunerative prices, even from California, by a five months' voyage; and much of the reasoning of Malthus and Mr. Mill is being refuted or antiquated by facts.

Fan. In applied Mechanics, the name *fan* is generally used to designate the machine used for the purpose of procuring a powerful current of air, for ventilating or for smelting purposes. Fans of this kind usually consist of a shaft, bearing a series of arms, upon which are fixed the sails or blades, working in a close box of a peculiar helicoidal form, and able, through an opening around the bearings of the shaft itself, to receive the air to be thence expelled through a passage which can be directed and regulated as may be required. According to the purposes for which the draught of the fan is needed, the velocity of revolution and the pressure of the air at the outlet are made to vary in every conceivable manner; but as the air when set in motion by the action of a fan follows the laws which govern the imponderable fluids in respect to the interference produced by changes in the direction of the vein, it follows that the inlet pipe should be always placed as near as possible to the working part of the fan, and that the outlet pipe should be as free from curves or abrupt changes of direction as possible.

Fan, Fanners, or Fanning Machine (Lat. vannus). A machine for separating the chaff, husks, dust, or other light matters from seeds which are to be preserved for sowing, or for some other purpose in general or domestic economy. The air is put in motion by the revolution of a wheel with leaves or fans instead of spokes, and the current is directed in a stream against the seeds to be fanned; these are placed in a hopper, so regulated as to proportion their descent through the stream of air to the force of the current created by the fan-

wheel. Before fanners were invented, the process was performed by hand in a manner the reverse of what is now done by machinery; that is, the seeds and refuse to be separated from them were taken up in shovelfuls, and thrown to as great a distance as possible through the calm air. The full-bodied seeds, being the heaviest, fell at the greatest distance, the chaff and other matters falling nearer, according to their degree of lightness. In course of time, a system of screens and sieves was added to the fanning machine. This apparatus, called a *winnowing machine*, not only separates the chaff and other light matters generally from the heavy matters, but parts both according to their bulk and weight: so that the seed comes from the machine fit for being measured up for the market or store room, the various kinds of inferior products being in a state fit for immediate use.

Fan Palm. The name given to various species of Palm-trees, having leaves of a fan-shaped form; but especially applied to *Corypha*, one species of which, *C. umbraculifera*, a native of India and Ceylon, forms a tall tree sixty or seventy feet high, the straight unbranched trunk crowned by a head of enormous leaves with a petiole seven or eight feet long, and the blade of the same length and thirteen or fourteen feet wide, with from ninety to a hundred segments. The species of *Chamærops* are in gardens commonly called *Fan Palms*; and others are furnished in the genera *Sabal*, *Borassus*, *Mauritia*, *Livistonia*, *Thrinax*, &c.

Fan Vaulting. A beautiful form of vaulting used in the perpendicular style of mediæval architecture in England. It has been described by Professor Willis as consisting in voussoirs commencing at the springing concentrically in plan, and proceeding thence towards the centre, cutting into each other, and very frequently finishing with a large pendent, which forms a kind of keystone. The under surfaces are, therefore, curved all ways, and are not plane in any section as the ordinary vaulting; they in some degree resemble pendentives, and meet together in the centre like portions of domes. The finest specimens are at Ely and Peterborough; King's College Chapel, Cambridge; St. George's Chapel, Windsor; and Henry VII.'s Chapel, Westminster.

Fanatic (Lat. fanaticus, from fanum, a *temple*). A person who, in matters chiefly relating to religion, adopts, under the influence of his feelings alone, the wildest and most extravagant opinions. The term *fanaticus* was applied anciently to priests of Cybele, Bellona, or other gods, who performed their sacrifices in a wild and extravagant manner; and hence has been bestowed in modern times on those who make pretensions to inspiration, or who conduct their worship with extravagance or licentiousness.

Fancy. [IMAGINATION.]

Fandango (Span.). An air for dancing to, in triple time, and of a quick and lively character. It is the favourite dancing air of the Spaniards, among whom it is of great antiquity. The dancer is usually provided with castanets—a practice borrowed from the Moors—which serve to mark the time more distinctly than a stringed instrument alone would do.

Fanfare (Fr.). A flourish of trumpets: hence the word *fanfaronade* is often used to denote boastfulness.

Fantasia (Ital.). In Music, a species of composition in which the author ties himself to no particular form or theme, ranging as his fancy leads amidst various airs and movements. Rousseau in his definition of this word confines its meaning to extempore composition, and makes this distinction between the *capriccio* and the *fantasia*: namely, that the former is a collection of singular and whimsical ideas strung together by an excited imagination and written down at one's leisure, whilst the latter is an off-hand display of whatever comes across the mind at the instant of execution.

Fantoccini (Ital.). Dramatic representations in which puppets are substituted in the scene for human performers.

Farce (Fr. from Lat. farcire, *to stuff*). In English Dramatic Composition, a short piece of low comic character. The original term seems, like the Lanx Satura of the Romans, which gave its denomination to the satire, to signify a miscellaneous compound or mixture of different things. In modern languages it has borne various significations. Certain songs which were sung between the prayers on the occasion of religious worship are said to have been denominated *farces* in Germany, during the middle ages; whence the word appears to have denoted simply an interlude of any kind. In England, the farce appears to have risen to the dignity of a regular theatrical entertainment about the beginning of the last century; since which time it has formed one of the most popular of our exhibitions, being usually performed, by way of contrast, after a tragedy at the national theatres. The farce is restricted to three acts as its limit, but frequently consists only of two or one. Of all the pieces of this class which have successively amused English audiences, none have acquired a permanent literary reputation except those of Foote, in whose farces the license of the theatre in satirising living persons was carried to the utmost height. The *Fabulæ Atellanæ* of the Romans, which appear to have been short dramatic entertainments of a miscellaneous character, sometimes pastoral, sometimes tragicomic, &c., but not so coarse in plan or diction as the *Mimes* and *Exodia*, which were satirical dialogues in verse between some set characters or stage-buffoons, appear to have filled in some respects the place of the modern farce. On the French stage the vaudeville answers to the English farce. [VAUDEVILLE.]

Farcy or **Farcin** (from Lat. farcio, *to stuff* or *cram*). A disease of the horse which affects the lymphatics of the skin, either generally producing a distended appearance of the vessels like moles or buttons, when it is called the *bud* or *button farcy*; or locally, when it is

chiefly confined to dropsical accumulations in the legs, and is called the *water farcy*. Both forms of the disease are contagious, and difficult to cure. The button farcy is generally removed by burning off the buttons by caustics or a red-hot iron, and by the exhibition of mercury; and the water farcy by the exhibition of mercury alone. Both diseases are sometimes cured by feeding the animal entirely on green food. (Blaine's *Encyclopædia of Agriculture*, 2nd edition, page 985.)

Farina (Lat.). Meal or flour, obtained by grinding and sifting wheat and other seeds; hence the term *farinaceous food*.

Farinose (Lat. farina). In Botany, applied to parts covered with a white mealy substance, such as may be seen in many varieties of the Auricula.

Farm (Mr. Wedgwood connects this word with A.-Sax. feorm, *hospitality*, lands being let originally on condition of supplying the lord with so many nights' entertainment for his household; but the French *ferme* points with greater probability to the derivation from Lat. *firmare*, denoting lands leased or *confirmed* to a tenant). In Agriculture, a farm is a portion of land, with suitable buildings, fences, and other arrangements necessary for carrying on the business of farming, which is let to the farmer or occupier for rent. Farming is no doubt coeval with the invention of property in land; because we may suppose that when a proprietor had taken possession of a portion of territorial surface, and called it his own, he would require the assistance of various persons to cultivate it; and these persons he could only remunerate by giving them a share of the produce. Hence the origin of what on the Continent is called the *metayer* system—in which the landlord supplies the farmer or tenant with the soil, buildings, and the whole or a certain portion of the stock; while the latter supplies the labour of cultivation and management, and takes as a remuneration the half or some other share of the produce. In process of time, as the tenants or farmers began to acquire capital, they furnished the whole of the live and dead stock, as well as the labour of cultivation and management, and paid the proprietor or landlord a fixed rent in money or produce. To enable the tenant or farmer to do this with the greater security, leases were invented, by which the tenant holding the land for a certain number of years was enabled to lay out money for its improvement at the commencement of his lease, and to receive it back again in the form of increased produce before its termination.

At the commencement of this system of what may be called *free farming*, all farms were undoubtedly of very limited extent; but with the increase of capital and skill on the part of the farmer they have become greatly enlarged. Much has been written respecting the most profitable size of farms for the public; but this may safely be left to the interest of the parties immediately concerned. Whatever size of farm brings in the highest rent to the landlord will be the best size for the public; because the higher the rent, the greater the amount of the produce that must be sent to market to pay it. That there is a natural limit to the size of farms, there can be no doubt; but what this is, is a different question, and has no connection with the other. It depends on the character of the surface, the kind of farming, and the climate. But though there is a natural limit to the size of farms, which in any given case can be readily defined, there is no limit to the number of farms that an individual may hold but those of his capital and his skill.

Farmer's Rents. The practice of letting estates at rack rent, i.e. at the full annual value of the land, to persons possessed of sufficient capital for cultivating the soil in the most effectual manner, is almost peculiar to this country, the form of tenure prevailing in other communities being almost invariably that of proprietorship, in small parcels, of lands held at labour rents, or of metayer tenancy.

If the system on which lands are let to farm secures the greatest rate of production at the least cost, it is, from an economical point of view, wholly unimportant that the ownership of the soil should be the property of one man, the use being purchased by an annual payment by another. The political consequences of such a form of tenure are another affair, though they need not be discussed here.

The system of farmer's rents is very ancient in England, having arisen side by side with numerous small properties possessed by free tenants and villeins, in the period subsequent to the great pestilence of 1348. Up to this time, few farmers in the modern sense of the word existed. But the wages of labour, despite the various statutes passed to regulate them, rose so considerably in consequence of the vast mortality of the pestilence, that it was no longer profitable for the lords to manage their estates by bailiffs, or to cultivate them at their own charge. Hence the origin of farmer's rents. At first the landlord advanced certain quantities of seed, stock, and implements, under condition that they should be replaced at the expiration of the term, or, as was more general, paid for at a fixed sum. This custom was, however, speedily abandoned, the great abundance of the harvests during the latter part of the fourteenth century having rapidly put the farmers into easy circumstances. After the middle of the fifteenth century, it would probably be impossible to find any accounts of a character analogous to those which are so abundant in the thirteenth and fourteenth centuries, those namely of the bailiff of a landlord cultivating the soil for the benefit of the owner.

Farmery. The buildings and yards necessary for carrying on the business of a farm. Their situation should be central to the farm lands, in order that the distance from which the crops are brought from the fields to the farmery, and the manure carted from the farmery to the fields, may be reduced to the lowest degree; for when the farm buildings are on one

side of the farm lands, it is evident that the cartage to or from the more distant fields must be attended with considerable loss of labour and time. The main purpose of the farmery is shelter for live stock, and security for the grain and other produce.

Farming. The business of farming, or the cultivation of lands held on lease, necessarily varies in different countries and climates; but one point is common to them all, viz. that no article shall be cultivated which shall not fully remunerate the cultivator or farmer within the limits of his lease. Hence, as few leases in any part of the world exceed twenty years in duration, timber trees are never objects of cultivation by farmers. As a business, farming may be described as that which under ordinary circumstances yields a lower degree of profit than any other mode in which capital and skill can be employed; but where abundance of capital and extraordinary skill are brought to bear on farming, its profits, on an average of a long series of years, may perhaps be not much inferior to those of commerce and manufactures. The great advantages of farming as a pursuit are—1. As the articles produced are of the first necessity, there is always a market for them at some price, without much exertion on the part of the farmer; 2. The certainty of always having a home and the means of existence on the farm; and 3. The comparative degree of independence which these circumstances are calculated to create in the mind. These advantages, however, depend much on the length of lease, and on the rent being equitable.

Farming of Taxes. In early and rude systems of finance, before the principles of economical taxation are studied, or indeed cared for, it has always been customary to estimate the probable proceeds of a tax at a certain sum, and to let out the collection of it either to some official especially appointed for the purpose, or to an individual or association at an auction price. The contractor who agreed with the administration to collect the tax, was known among the Greeks by the name τελώνης, among the Romans by that of *publicanus*.

Extraordinary powers were given to these officials, and these powers were generally abused. Hence the farmer of taxes was an object of general dislike, and not unfrequently held to be civilly infamous. He was so among the Greeks, for we find an apology for the practice in Aristotle's *Rhetoric*, where, illustrating the topic of what is called parity of reasoning, he makes the contractor say, 'If it is not infamous for you to let the taxes, why should it be infamous for us to farm them?' and everyone knows the disrespect in which the *publican*, or agent of the Roman tax-gatherer, was viewed by the Jews. In Rome the publicani were a corporation, who contrived by means of combination to get the taxes hired to them at moderate terms, and contrived to secure enormous profits on the undertaking. The miserable provincials were forced, in order to meet the demands of the Roman fisc, to borrow sums of money at prodigious rates of interest from the knights, the regular money-lenders of ancient Rome, and were thus steadily impoverished. The publicani were, indeed, a very important order in the Roman community, for it was to them that the government looked when loans were needed in times of financial difficulty, and they were therefore supported under all circumstances, though the government was well aware of their extortionate proceedings.

The customs in this country have been occasionally let out to farm. In 1282, when the contract was taken by foreigners, they produced 8,411*l.* 19*s.* 11*d.*; and we read that in 1329 they were farmed again, the produce being less. In the reign of Elizabeth they were farmed by one Smith, and rose from 14,000*l.*, the amount of his first contract, to 42,000*l.*, and ultimately to 50,000*l.* In 1666 they were farmed for 390,000*l.*

It is hardly necessary to say, that such a method of collecting revenue is certain to be wasteful, oppressive, and vexatious, and to create great disaffection. Hence the practice has been almost universally abandoned by modern civilisation.

Farriery. The art of the farrier (Ital. ferraro, ferratore, from Lat. ferrum, *iron*), now generally termed the VETERINARY ART [which see].

Farrow (Swed. farre, *a boar*, Lat. verres). A sow is said *to farrow* when she brings forth pigs; and the pigs brought forth are called a *litter* or *farrow*.

Farthing. A small English copper coin, amounting to one-fourth of a penny; it was anciently styled *fourthing*, as being the fourth of the integer or penny.

Farthingale (Fr. vertugadin, Port. verdugada: Wedgwood). A name given to the hoop of whalebone used formerly by the ladies of this and other European countries to spread out the petticoat to a wide circumference. It was introduced into England in the reign of Queen Elizabeth, and continued to be used on state occasions down to the commencement of the present century. (Strutt's *Manners and Customs.*)

Fasces (Lat.). In Ancient History, some of the insignia of authority of the chief magistrates of Rome. They consisted of bundles of wooden rods, enclosing an iron axe (called *securis*) so that its head appeared above; and were used as instruments of punishment, the rods being applied for minor offences, and the axe for capital crimes. They were carried before the magistrates by officers called *lictors*, and the number appointed to each varied for the different magistracies. Thus the civic prætors had two, proconsuls and provincial prætors six, the consuls twelve, and dictators twenty-four. The municipal decemvirs also had the privilege of having two fasces carried before them in their own towns.

Fascia (Lat.). In Architecture, a flat member in an entablature, or elsewhere, like a flat band or broad fillet. The architrave, when

subdivided, for instance, has three bands called *fasciæ*; of which the lower is called the first, the middle one the second, and the top one the third fascia; or the plinth may likewise be divided into fasciæ, which are called according to their number. [ORDER.]

FASCIA. In Botany, a cross band of colour. Hence any surface which is marked by transverse bands of colour is said to be *fasciate*.

Fasciæ. In Anatomy, the tendinous expansions of muscles. The *fascia lata* is a strong tendinous sheath of the muscles of the thigh.

FASCIÆ. In Astronomy, bright stripes or belts observed on the discs of some of the planets, particularly Jupiter and Saturn. The fasciæ or belts of these planets are sometimes broad and sometimes narrow. The less luminous spaces between them have been generally believed to be breaks in the clouds which constantly float in their atmospheres. The clear portions are sometimes of a rose tint. This word is now rarely used. [JUPITER.]

Fascicle, Fasciculus (Lat.). In Botany, a form of inflorescence exactly similar to that called a *corymb*, with the exception that the expansion is centrifugal in place of being centripetal.

Fascicularia (Lat. fasciculus, *a bundle*). A genus of extinct Zoophytes, whose calcareous cases are in the form of tubes aggregated together in conical bundles, like those of the organ-pipe coral (*Tubifora*). The *Fasciculariæ* are abundant in the English coralline crag formation.

Fasciculate (Lat. fasciculus). In Botany, when several similar parts grow in a bundle from a common point, as the leaves of the larch, the tubers of the *Dahlia*, &c.

Fascination (Lat. fascinatio, from fascino, Gr. βασκαίνω—akin to φημί—*to enchant*). The fact of being charmed, operated upon, or influenced by the look of certain individuals, generally taken in an evil sense. *Fascination* is the power supposed to be possessed by certain persons of working mischief to others by means of a glance of the eye. Among the Romans the god Fascinus was invoked as a protector against this influence. Virgil alludes to it thus:—

> Nescio quis teneros oculus mihi fascinat agnos.
> *Eclog.* 3.

It is to this day a common belief among the vulgar in almost all countries; but probably it is nowhere more generally retained than in Turkey and Italy. In the former country, the Mussulmans deem it necessary to have recourse to a variety of amulets and charms, in order to preserve themselves from the evil eye of an enemy, or of an infidel. In Naples, the evil eye and its fascination (known to them by the name of *gettatura*) are subjects of dread and superstitious precaution among all classes of the people. There is a treatise on fascination by Vairus, prior of a convent at Benevento in that country (1589); another by Frommann (1675).

Fascines (Fr.). In Fortification, faggots formed of brushwood, tightly bound together. They are used to revet parapets, and for other purposes.

Fasciolaria (Lat. fasciola, *a swathing-band*). A genus of Pectinibranchiate Molluscs, dismembered from the rock-shells (*Murices*) of Linnæus on account of the smooth band-like surface of their windings which have not any *varices*, and distinguished from the species of *Fusus* in having plaits on the columella, which are oblique, and consequently spiral.

Fashion (Fr. façon, from the Lat. facere, *to make* or *form*). A term used to signify the prevailing mode or taste in any country, the only recognised quality which it possesses being mutability.

Fashion-pieces. In Shipbuilding, those timbers which give shape or fashion to the stern, by forming a connection between the sternpost and the aftermost ribs of the ship's sides.

Fassite. In Mineralogy, a variety of *Augite* from Fassa in the Tyrol.

Fastern's Eve. A name, still retained in Scotland, for Shrove Tuesday, or the day immediately preceding the Lenten fast.

Fasti (Lat.). In Ancient History, the records of the Roman state, in which all public matters, military and civil, were registered by the high priest, according to the days on which they took place. The *Fasti* of Ovid is a poem giving an account of the Roman year, and the ceremonies attached to the different days, with their historical or mythological origin. The first six books, containing the first six months of the year, beginning with January, have come down to us; the rest are lost.

Fastigiate (Lat. fastigiatus or fastigatus, *sharpened like a pyramid*). In Botany, a term applied to plants of a pyramidal or tapering habit of growth, as exemplified in the branches of the Lombardy Poplar.

Fastigium (Lat.). In Architecture, the slope or fall of any surface or plane; the inclination given to the sides of a building; the gable or the inclined ends of a pediment.

Fasting. In a Theological sense, the abstaining from food as a religious observance. [ABSTINENCE.]

The great fast of the Christian Church is that of Lent, from Ash Wednesday to Easter Eve. The number of other fast days throughout the year varies in the Eastern and Western Churches.

For the great fast of the Mahommedans, see RAMADAN.

Fats, Fat or **Fixed Oils.** The ultimate elements of these substances are carbon, hydrogen, and oxygen. They are common to animals and vegetables: they vary in consistence from thin oil (olive oil) to hard fat (suet). When pure, they are neutral, and leave a greasy spot upon paper, which does not disappear when moderately heated. They are insoluble in water, but more or less soluble in alcohol and ether, and are insipid and inodorous. In vegetables they chiefly occur in the seed and

in the pericarp of the fruit (olive), and are generally obtained by pressure, with or without the aid of heat. In animals, the adipose cells are easily ruptured by heat, which liquefies and expands the fat, so that it runs out and collects upon the water in which the crude fat is boiled. The melting points of oils and fats vary from about 20° to 140°. At high temperatures (500° to 600°) they do not distil unchanged, but evolve acrid products, and are resolved, at a red heat, into inflammable gases and vapours, of high illuminating power. Their specific gravity, which is below that of water, varies much with temperature: the specific gravity, for instance, of hog's lard at 60° is 0·938; in its fluid state at 122° it is 0·892; at 155° it is 0·881; and at 200°, 0·863. Some of these oils are little affected by exposure to air, but gradually become rancid; others absorb oxygen, and form a resinous varnish; they are known as *drying oils*; and when their surface is much extended, as in greasy rags and cotton-waste, this change is sometimes attended by spontaneous combustion. [OILS.]

When the solid fats are subjected to pressure between folds of bibulous paper, they afford more or less of fluid oil; and when the liquid oils are cooled to about 32°, they deposit more or less of a concrete matter. The liquid portion is termed *oleine* or *elaine*, and the solid *stearine*, with which a variable portion of *margarine* is associated. Oleine, stearine, and margarine, are each of them compounds of a distinct *fatty acid*, with a sweet principle, *glycerine*. These acids are the *oleic*, the *stearic*, and the *margaric*; so that oleine is an *oleate*, stearine a *stearate*, and margarine a *margarate*, of glycerine. Besides these, many fats contain distinct volatile acids, such as *butyric*, *capric*, and *caproic acids*, in butter; *hircic acid* in goats' fat; *phocenic acid* in fish-oil, &c. Oleine may be more or less separated from stearine by ether or oil of turpentine, in which liquids it is much more soluble than stearine.

In the process of *saponification*, the fatty bodies are heated with hydrated alkalies, generally with soda, by which they are decomposed, the glycerine is set free, and *oleates*, *stearates*, and *margarates* of the alkaline bases are formed.

These combinations (soaps) are in their turn decomposed by the greater number of other acids, and the fatty acids are separated. These acids are insoluble in water, but soluble in alcohol and in ether, and are less fusible than the original fats. They are also soluble in oil of turpentine and in benzole, and when free from volatile products are insipid and inodorous. The soaps of alkalies are soluble, but those of the alkaline earths, and of most of the other metallic oxides, are insoluble in water; hence it is that *hard waters* are unfit for washing, in consequence of the earthy salts which they contain, and which give rise to the production of insoluble soaps. [SOAP.]

Fata Morgana (Ital.: called also *Castles of the Fairy Morgana*, the spectacle being supposed to be under the influence of the Queen of the Fairies, the *Morgan la Fay* of popular legends). A remarkable phenomenon of *mirage* or atmospheric reflection mentioned by different authors and travellers as seen in the straits of Messina, especially in the vicinity of Reggio. It exhibits in the air, over the surface of the sea, multiplied images of the objects on the surrounding coasts. It is thus described by Minasi: 'A spectator on an eminence in the city of Reggio, with his back to the sun and his face to the sea, and when the rising sun shines from that point whence the incident rays form an angle of about 45° on the sea of Reggio, sees upon the water numberless series of pilasters, arches, castles, well delineated, regular columns, lofty towers, superb palaces with balconies and windows, villages and trees, plains with herds and flocks, armies of men on foot and horseback, all passing rapidly in succession on the surface of the sea.' There can be little doubt that this description, which has been frequently copied, and even admitted into treatises on optics, has received considerable embellishment from the aid of the imagination. Captain Smyth, in his excellent work on Sicily, observes, 'I never met with a Sicilian who had *actually seen* anything more than the loom or "mirage" consequent on a peculiar state of the atmosphere; but which, I must say, I have here observed many times to be unusually strong.' (*Memoir descriptive of the Resources, Inhabitants, and Hydrography of Sicily and its Islands*, p. 109.) [MIRAGE.]

Fatalism. The belief in an overruling fate or destiny which annihilates free will and controls all human actions. For the philosophical doctrine of fatalism, see NECESSITY; for those religious opinions which have assumed a similar character, see ELECTION and PREDESTINATION.

Fate. [DESTINY; NECESSITY.]

Fates (Lat. fatum, *that which is spoken*, as the Gr. *αἶσα* is akin to Lat. aio, *to speak*). In Mythology, the three sisters Clotho (spinster), Lachesis (allotter), and Atropos (unchangeable), whose office it was to spin the destinies of men, and break the threads at their appointed hour of death. They were called Parcæ by the Latins. Their Greek name was Μοῖραι, i.e. *the Dispensers*.

Fathers of the Church. The early Christian writers whose works have thrown light upon the history, doctrines, and observances of the primitive church, and who are thereby entitled to be regarded as witnesses to the faith and practice of the first believers. The period to which the list may be extended is, of course, arbitrary. St. Bernard in the twelfth century is generally styled the last of the Fathers. The writers of the first century, or who were contemporary with the first disciples, are distinguished by the term *Apostolic Fathers*. The general character of the writings of these celebrated men, their trustworthiness as witnesses, their authority as judges in matters of doctrine and discipline, and the utility of studying their works, have been discussed by divines with far more of prejudice and the

spirit of system than the love of truth. A voluminous controversy was carried on upon this subject, towards the end of the seventeenth century, between some Protestants, chiefly of the Calvinist churches, who attacked the Fathers, and others, both Protestant and Catholic, who defended them. On the former side, two works of some notoriety were produced: Daillé's *Treatise on the Use of the Fathers*; and Barbeyrac, *Morale des Pères de l'Église*. Among many answers, may be cited that of Cellier to Barbeyrac, 1718. In England, Burnet, Hill, Peter Allix, Reeves (*Apologies of the Early Fathers, with Dissertations*, 1709), took part in it. The Benedictines of Paris, in the seventeenth century, published valuable editions of the principal Fathers, both Greek and Latin. Nourry, a learned member of that order, published an *Apparatus* to Despont's great collection, the *Bibliotheca Patrum*, in which much information is collected.

Fathom (A.-Sax. fæthm; Dutch, vadem). An English measure of length, equal to two yards or six feet, and founded on the distance between the finger-points when the arms and hands are extended horizontally. It is the unit of length in all matters of nautical surveying.

Fattening Domestic Animals. The object of fattening is to accumulate flesh and fat for sale. The means used by all fatteners of domestic animals, whether quadrupeds or poultry, are: preventing the animals from taking exercise, and tempting them to eat by the variety and quality of their food. The best system is called *box-feeding*, by which a dry and warm lair is provided along with opportunity for a minimum of exercise.

Fatty Acids. Fats and fixed oils are composed of an acid or acids united with the base glycerine. The glycerine may be displaced on boiling the fat with any stronger base such as potash or soda, the acid uniting with the latter to form *soaps*. When a soap is heated with strong acids such as hydrochloric or sulphuric acid, the base is removed and the fatty acid obtained in the free state.

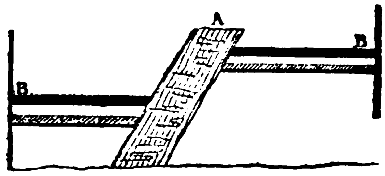
The term is also sometimes made to include acetic and formic acids, which, though not themselves oleaginous, yet belong to the same chemical series. [FATS.]

Fauces (Lat.). The posterior part of the mouth, terminated by the *pharynx* and *larynx*.

Faujasite. A hydrated silicate of alumina, lime, and soda, from Baden; named after Faujas St. Fond.

Fault. In Geology, a fracture of strata, accompanied by a sliding down or a thrusting up of the deposits on one side of the fracture to a greater distance than the other. The broken beds are thus no longer continuous; and as these fractures cause frequent interruptions of work in mining, they have long attracted attention, and are recognised under different names wherever underground operations are carried on. The disruption is often accompanied by a wide gap filled up with clay, or even stones and rubbish. The synonyms of *fault* are *slip, throw, trouble, drop.*

To the geologist the fault is a proof of elevation or depression, and often points to the direction of the elevating force; but as strata of great value (such as coal and ironstone) have very often been subject to this accident, it is a matter of importance in practical geology to understand the mechanics of the event, in order that a lost bed may be followed. In the annexed diagram, B may represent a bed broken asunder and separated by a *dyke*, A (the dyke being a wide fissure accompanying a fault).



Whether the thickness of the dyke or fault (A) is great in proportion to that of the bed faulted (as represented in the diagram), or a mere line as sometimes happens, it is always possible to lay bare a little of it, either at the surface or at the point where it is reached underground. If when thus laid bare, the angle made by the plane of the bed with the plane of the fault is more or less than a right angle, the position of the lost part of the deposit, above or below the part worked, may be discovered by a simple observation. The direction of the line that makes an obtuse angle will be that which points to the broken bed. Thus, if in the diagram the fault is cut from the right, the bed beyond is at a lower level; if from the left, it is at a higher. This will always be the case, from the mechanical conditions of the problem. There are some apparent and a few real exceptions, owing to peculiar and complicated mechanical conditions of the disturbance. The remembrance and application of this law are very important in coal-mining.

Faults are of various magnitude; some of the smaller faults are only a few inches in drop, others a foot or two. Both these may be due to contraction and cracking of the bed, and not to elevation; for when a mass is broken, a different pressure of any kind will produce a minute change of level. Such small faults are called *slips*. Larger faults are of all magnitudes up to many hundred fathoms; but it must not be forgotten that the enlargement of a fissure once made may take up an almost indefinite time, and be carried to almost any extent very gently, the removal of the rising sides being in progress during the whole upheaval, and no violent movement taking place at any time.

Faults are best known in the coal measures, because in these beds their influence is most important. They are common, however, in all rocks, and in brittle rocks may be noticed by thousands in every quarry. The larger faults are not confined to mountain regions, some of

the most important occurring in countries now nearly level. No doubt in these cases there has been enormous denudation during the growth of the fault.

Occasionally the contents of the interspace connected with faults, being impermeable to water, serve as backs to prevent water from running along sandy or loose beds, and may thus be useful to the miner. They are, however, not less frequently troublesome and mischievous. So, also, if they have sometimes brought to the surface minerals that would otherwise have been lost, they have perhaps quite as often carried beds of minerals away.

Fauna. The animals peculiar to a country constitute its *fauna*. The term is derived from the Fauni of Roman Mythology. [FLORA.]

Faunus. An Italian rural deity resembling the Grecian Pan, and, like him, having the gift of prophecy. Mention is sometimes made of several Fauni, who were represented, like the satyrs, with the horns and feet of goats. There was an annual festival instituted to their honour, called *Faunalia*.

Fausse-braye. In Fortification, a low rampart round the body of the place, parallel to the main rampart.

Faux (Lat. the old nom. sing. of fauces). In Botany, the orifice of the tube of the corolla, the tube being formed by the confluence of the petals.

Favose or **Faveolate** (Lat. favus, *a honeycomb*). In Botany, honeycombed; cellular.

Fayalite. A native silicate of iron from the island of Fayal.

Fayence. [FAIENCE.]

Fealty (Lat. fidelitas). In Feudal Law, the oath of fidelity (Fr. féauté) taken by every tenant on admission to be true to his superior lord. General fealty is that due from the subject to the prince; special fealty from tenant to mesne lord. Fealty is said to differ from homage in being due to every new lord. The oath, as administered in England, was fixed by stat. 17 Edw. II. c. 2; but it has long been obsolete, although, in copyhold tenements, the memory of it is still preserved by the customary entry of respite of fealty on the admission of a new tenant.

Feasts or **Festivals** (Lat. festivus, from festus, *festal*). Days set apart by the church, either for the celebration of the most remarkable events connected with the scheme of redemption, or to commemorate the actions and sufferings of such persons as have been most instrumental in carrying forward the designs of God for the salvation of mankind. This was a practice of the primitive church; but in process of time (as early as the fourth century) the great number of names which had been introduced into the calendar rendered its observation both burdensome and superstitious. The church of England retains the festivals of the nativity, circumcision, manifestation, the death, resurrection, and ascension of Christ, the purification of the Virgin and the annunciation (or Lady-day), Whit-Sunday in honour of the Holy Spirit, and Trinity Sunday. Besides these, the most remarkable of the apostles and the evangelists are commemorated on their respective days; and one day is set apart for the remembrance of all the saints. A few names of later saints were still retained at the Reformation, as a compromise with the prejudices of the people, but no services are connected with them. The saints' days of the former class are called *red-letter*, those of the latter *black-letter* days, from the colour in which they were originally printed in the church calendar. Festivals are either movable or immovable; the former depending upon Easter, the latter being fixed to certain days of their respective months.

Feather-edged. In Architecture, a term which is applied to a board which has a triangular or rather a trapezoidal section; one edge being thinner than the other. The term is also applied to stone coping or other work of a similar kind.

Feathering. In Rowing, the act of turning the blade of the oar, while emerging from the water preparatory to being thrown forwards for another dip, from a vertical to a horizontal position. The oar thus turned offers less resistance to the wind or to the water should waves strike it, and has a more elegant appearance.

Feathers (Dutch, veder; Ger. feder; Swed. fjæder). This term, in Zoology, is restricted to those productions of the dermal system which form the most exterior covering of birds, and which consist of the following parts, viz. a quill (*calamus*), a shaft (*rhachis*), and vanes (*pogonium externum et internum*).

The quill is that part of a feather by which it is attached to the skin; it is nearly cylindrical in form, hollow, and semi-transparent, possessing in an eminent degree the opposite qualities of strength and lightness. The end which is implanted in the skin is more or less obtuse, and is pierced by an orifice called the *lower umbilicus*. At the opposite end, where it is continued into the shaft, and just at the meeting of the two lateral vanes, there is another orifice, called the *upper umbilicus*. The cavity of the quill contains an imbricated series of conical capsules, united together by a central pedicle, forming the membranous remains of the original formative pulp.

The shaft is quadrilateral, with a smooth convex surface, and an opposite concave surface traversed by a longitudinal impression continued from the upper umbilicus. It is covered by an outer layer of firm horny material like that of which the quill is formed, and this encloses a soft elastic substance called the *pith*.

The vane consists of *barbs* and *barbules*.

The barbs are attached to the sides of the shaft, and consist of narrow elongated plates, arranged with their flat sides towards each other, and their margins in the direction of the external and internal sides of the feather. By this disposition they offer much resistance to being bent out of their plane, though readily yielding to any force acting upon them in the line of the stem.

The barbules are minute and often microscopic processes, given off from either side of the barbs, and arranged in a single series, just as the barbs are placed with reference to the shaft. In true feathers, they are short, stiff, and curved in opposite directions on opposite sides of the barb; and the concavities of one series of barbules interlock with those of the adjoining barbs, so that the whole vane presents a continuous and resisting surface, as in the quill-feathers of most birds. When the barbules are long and disjoined, the feather is termed a *plume*; in the long dorsal plumes of the peacock, the barbules themselves are ciliated.

In a few instances, as the apteryx and ostrich, the feathers are simple. In most birds each feather is complicated by a part termed the *accessory plume*. This is usually a small downy tuft; but it varies as to its size both in different species, and even in the feathers of different parts of the body of the same bird. In the body-feathers of the hawks, grouse, ducks, gulls, &c., the accessory plume is generally well developed, and acquires in some species a size equal to that of the feather from which it is produced. In the emeu this is the case with the whole plumage, and the quill of each feather supports two shafts. In the cassowary there are two accessory plumes, one of which is equal to the size of the original feather, the other is much smaller.

Feathers vary in form, size, and function, in different parts of the bird, and have accordingly received distinct names in ornithological science. Thus the feathers which surround the external opening of the ear, and which serve to augment the intensity of sound, are termed the *auriculars*. Those which lie above the scapula and humerus are called the *scapulars*. The small feathers which are arranged in imbricated rows upon the bones of the antibrachium are called the *lesser coverts* (*tectrices primæ*); those which line the under or inner side of the wings are the *under coverts*. The feathers which lie immediately over the quill-feathers are the *greater coverts* (*tectrices secundæ*). The largest quill-feathers of the wing, which arise from the bones corresponding with those of the hand, are termed *primaries* (*remiges primores*); those which rise from the ulna, towards its distal end, are the *secondaries* (*remiges secondariæ*); those which are attached to its proximal extremity are the tertiaries (*remiges tertiariæ* seu *parapterum*). The quill-feathers which grow from the phalanx commonly called *thumb* form what is termed the bastard wing (*alula spuria*). The quill-feathers which are implanted upon the os coccygis are called *rectrices*.

The developement of feathers is always preceded by that of down, which constitutes the first covering of young birds. Each down-fascicle consists of a small quill, supporting a bunch of equal-sized finely-ciliated filaments. The down-fascicles are succeeded by the feathers, which they guide, as it were, through the skin; and the feathers of each succeeding plumage serve, during the moult, as the *gubernacula* of those which follow.

The mechanism concerned in the formation of a feather is, as might be expected, of a very complicated character. It consists of vascular parts which secrete the material, and of moulds or capsules, in which the fluid material is thrown into the proper form; the whole is enclosed in an outer sheath, which is protruded with the new-formed feather from the skin, and which, becoming dry and friable from contact with the atmosphere, crumbles away, and leaves the feather free to unfold its beautiful and complicated structure.

For the laws which regulate the varieties and changes of plumage, see INDUMENTUM.

Feathers, in reference to their chemical composition, may be regarded as indurated albumen, their ultimate elements being carbon, hydrogen, oxygen, nitrogen and sulphur. The ash of feathers, especially of birds which live on grain, contains, however, a large proportion of silica. The colours of feathers are due to peculiar organic pigments which may be separated by proper solvents; the beautiful play of colours which some of them exhibit is referable to a decomposition of light analogous to that produced by mother-of-pearl and similar striated surfaces.

Febrifuge (Lat. febris, *fever*, and fugo, *I drive away*). A remedy which cures or relieves fever: the term is commonly applied to medicines used in the treatment of agues.

February (Lat. Februarius). The second month of the year, containing twenty-eight days in common years and twenty-nine in leap years, the intercalary day being given to it as the shortest month. For the position of February in the ancient Roman calendar, see Sir G. C. Lewis, *On the Astronomy of the Ancients*, p. 45.

Fecials or **Fetials** (Lat. fetiales). The Roman heralds, whose peculiar office it was to declare war and conclude peace. The former office they performed with the following ceremonies: They were first sent to demand redress; if it was not given within thirty-three days, they returned to the confines of the hostile state and threw a bloody spear within them, having proclaimed war according to a given formula before not less than three adult witnesses. The fecial, who took the oath in the name of the Roman people in concluding a treaty of peace, was called *Pater Patratus*. The college of fecials, said to have been instituted by Numa, is supposed to have been borrowed from the Greeks. They were probably twenty in number.

Fecula. [FÆCULA.]

Federal Government (Lat. fœdus, *a league* or *treaty*). A government formed by the union of several sovereign states, each surrendering a portion of its power to the central authority. But the amount of the power thus surrendered varies in different federations. Thus the government of the German empire as it existed before the French revolution, and that of the

United Provinces of the Netherlands, were both termed *federal*; and the Swiss cantons, under the present Swiss constitution, have retained more of their individual sovereignty than those of the United States of America, inasmuch as they have no permanent federal executive body, and their legislature, or *diet*, is little more than a meeting of delegates with full powers from separate republics to consider certain common concerns. [DIET.] The theory of the American constitution, on the contrary, recognises not only unity in respect of foreign relations, but also a common legislature, which alone has the right to impose certain taxes (such as customs) and to regulate the management of waste or public lands throughout the Union; as well as a permanent common executive, consisting of the president and his cabinet, charged with the superintendence of those branches of administration which regard the whole community. This being the theory of the federation, the events of 1860–61 precipitated the discussion of the great question of principle which had been raised more than thirty years before by South Carolina: whether a state could lawfully secede from the Union. It was contended, on the affirmative side, that the constitution does not expressly prohibit secession; on the negative side, that the constitution does not contemplate it as a possibility, and that the supposition is in itself destructive of the basis of the Union—arguments which may be, as they have been, reproduced with every variety of ingenuity; but the logic of the strongest is certain in such cases to prevail. (St. Croix, *Des Anciens Gouvernements Fédératifs*; Droysen, *Hellenismus*; Freeman's *Federal Government.*)

Fedia. This genus of *Valerianaceæ* yields the Corn Salad or Lamb's Lettuce, *F. olitoria*, a salad herb, much used on the Continent under the name of *Mache*. It is sometimes called *Valerianella*.

Fee Simple (Ger. fehde, Mod. Lat. feodum: hence the derivation of *fee* in all its meanings). In Law, an estate of freehold of inheritance in lands, tenements, or hereditaments. Tenant in fee simple absolute, or, as it is more briefly expressed, in *fee*, is one who has the fullest power of disposing of his tenement which the law allows; and not being disposed of by him either in his lifetime or by devise, it descends to his heirs general.

An estate to a man and his heirs qualified by a condition or limitation capable of abridging it, as an estate to A and his heirs on condition of paying a sum of money on a stipulated day, and if he fail to do so then to another, is termed a *fee conditional*; or, with less propriety of language, a *fee simple conditional*.

Fee Tail. In Law, arose out of the statute De Donis, 13 Edw. I.; which restrained the alienation of lands and tenements by one to whom they had been given, with a limitation to a particular class of heirs. A gift, for instance, to a man and the heirs of his body, constituted before the statute a fee simple conditional, which could be alienated as soon as a child was born to the donee: after the statute it became inalienable, until more latitude was given by the invention of certain refined fictions of law.

A deed creating an estate tail is properly called a *gift*, and the giver and receiver the *donor* and *donee*. Estates tail are *general*, where only one person's body is specified from which the issue must be derived; *special*, where both the progenitors are marked out, as in a gift to A and the heirs of his body to be begotten upon B. It may also be descendible to all the issue, or to male or female issue; in which case estates are said to be in tail male or in tail female. Half-blood is no impediment in the descent of an estate tail general. Where lands and tenements are given to a man and his heirs in special tail (by a wife named in the grant), and his wife dies without issue, the husband is tenant in tail after possibility of issue extinct; and his estate is in most respects equivalent to one for life only.

Estates tail being contrary to the general policy of the law, legal ingenuity was taxed in early times, to invent modes whereby they might be defeated; i.e. whereby the donee might destroy the special limitations of the gift, and acquire an estate in fee simple without incurring forfeiture. This was done by the fiction of *common recoveries* (of which the validity was established in the courts in the reign of Edw. IV.), and by that of fines, recognised by statute (4 Hen. VII. c. 24, 32 Hen. VIII. c. 36). A simpler process has been substituted for these ancient contrivances by the Act 3 & 4 Wm. IV. c. 74, by which the process of *barring an entail* was rendered easy. Donee in tail may now grant leases for twenty-one years, under 19 & 20 Vict. c. 120.

Fee-farm Rent. In Law, a rent charge in fee, issuing out of an estate in fee of at least one quarter of the value of the land at the time of its reservation. Some authorities consider the amount as immaterial. No grant in fee farm can be made since the statute of quia emptores.

Feelers. Organs fixed to the mouth of insects, generally less than the antennæ, and often jointed. [PALPS.]

Fees. In Law, perquisites allowed to ministers of justice, fixed either by Act of Parliament or ancient usage.

Fehmic Courts. [VEHMIC COURTS.]

Felis (Lat. *a cat*). The name given by Linnæus to the genus of Ferinæ or carnivorous quadrupeds, of which the common cat is an example. The essential characteristics of this genus are the strong, sharp, retractile talons with which all the four feet are armed, and the corresponding destructive nature of the dentary organs. These consist of six small incisors in each jaw, the exterior ones larger than the rest; two long and strong laniaries, bounding the series of incisors in the lower jaw; and two in the upper jaw of still greater length and strength, conical, sharp-pointed, slightly incurved, and separated from the incisors by an

interval corresponding in size with the summits of the inferior laniaries, which always pass, when the mouth is closed, in front of those of the upper jaw.

The molar teeth are four in number on each side of the upper jaw, and generally three on each side of the lower; the two anterior in each series are smaller than the third, and furnished each with a single conical pointed middle process. The third molar is the largest in both jaws, and presents a very characteristic form in the lower one being compressed, and terminating in two sharp-pointed trenchant triangular lobes, which play upon the inner surface of three corresponding lobes of the tooth above; the appulse of the lower carnassial or sectorial tooth is checked, and the upper gum defended, by an internal tubercle in the upper sectorial. The fourth molar in the upper jaw is placed within the posterior margin of the third, and presents a simple transverse slightly convex plate, affording additional surface for the inferior sectorial to work against. The claws and teeth above described are better adapted for the seizure and destruction of living animals than are those of any other mammalia; and the power of wielding these weapons is enjoyed in a corresponding degree of perfection. There are no quadrupeds in which the muscles of the jaws and limbs are more fully developed. The teeth, as we have seen, are few, though formidable: those of the lower jaw occupy only its anterior half; the rest of the jaw consisting chiefly of a broad and high coronoid, and a strong angular process for the implantation of the immense muscles destined for its movements. The skeleton of the feline animals presents a light but well-built mechanism: the bones, though slender, are extremely compact; the trunk, having to contain the simple digestive apparatus requisite for the assimilation of highly organised animal food, is comparatively slender, and flattened at the sides. The muscular forces are thus enabled to carry the light body along by extensive bounds, and it is thus that the largest felines generally make their attack. When the impetus of the spring is added to the stroke of the paw, the lion or tiger has power to fell an ox or smash the skull of a man at a single blow; and as the strength of the neck corresponds with that of the jaws and limbs, they are enabled to bear away with ease animals bigger and heavier than themselves. It fortunately happens that the feline animals have not the instinct of sociality, otherwise what could withstand a troop of lions or tigers hunting in concert like a pack of wolves?

The feline animals or cats constitute a well-defined and circumscribed genus. The leopards, panthers, jaguars, and tigers, are the most typical or truly feline species; in these the beauty of colouring, sleekness of skin, elegance of form, craft, suspicion, bloodthirstiness, agility under excitement, and sloth during repletion, are most strongly manifested. The lion combines more robustness of body with the feline attributes; and his pre-eminent stature receives an air of nobility and grandeur from the mane that decorates his head and neck. He has the credit, too, of a greater share of boldness and generosity than the other cats. His vocal organs also exhibit a modification of structure not present in the other felines, by which he has the power to utter his tremendous roar. Among the felines, one group is characterised by the shortness of the tail, and the tuft of hairs on the tip of the ears; this includes the lynxes.

The cheetah, or hunting leopard, *Felis (Cynailurus) jubatus*, deviates from the true feline character chiefly in the half-retractile condition of the talons and the upright carriage of his body; and with these physical modifications is combined so much of the canine disposition as enables this species to be used in packs for the purposes of the chase.

The middle-sized cats (*Leopardus*), which lurk in the branches of trees, as the leopards, ocelots, &c., have a fulvous ground colour, broken by irregular dark spots; a marking which admirably adapts them for concealment amidst foliage. A similar relation of adaptation to the peculiar theatre of their destructive habits may be traced in other species. The tiger, for example, which prowls on the ground and creeps stealthily towards his victim between the stems of the trees and plants of the jungle, has his bright ground colour interrupted with black vertical stripes. The lion, which traverses the parched deserts of Africa, and lies in wait to intercept the antelopes which bound in troops from one oasis to another, would be rendered too conspicuous if his tawny hide were ornamented by the stripes or spots that characterise the feline livery; these, therefore, which are obvious enough in the earlier periods of his existence, become obliterated as he attains to maturity. A smaller feline species, the puma, or American lion, which plays its part in a corresponding theatre of the New World, presents a similar uniformity of colour.

The feline animals bring forth from two to six young ones at a birth. The domestic cat is the most fertile; a circumstance which arises from the abundance of food, shelter, and protection, consequent on her alliance with man. But, as has been frequently remarked, this, of all domesticated animals, is the least servile or restrained; and though instances of personal attachment are not wanting, the affection of the cat is rather to the house than to its owner. There are many singularities in the nature of the cat, which perhaps our comparatively limited acquaintance with the other felines leads us to regard as peculiar to this species. She is remarkably nervous, and readily startled; gives out the electric spark when her fur is rubbed contrary to its direction, as is very conspicuous when this is done in the dark. Under the excitement of fear, the same effect is produced on the long hairs of the tail as if a stream of electricity were transmitted through them, and they all stand out from the surface to which they are attached, giving the tail an appearance

of treble its usual thickness; at the same time the back is raised, and the body drawn into its smallest compass. Cats are attracted by peculiar odours, and exhibit a violent fondness for catmint and valerian, rubbing their noses and rolling themselves in the latter with signs of great and uncontrollable excitement. Cats are very cleanly, are fond of warmth, and seek a soft place for their repose. They express their satisfaction by a peculiar soft vibrating noise, called *purring*.

Fellic and Fellinic Acid (Lat. fel, *gall*). Products obtained from bile.

Felling Timber. In Arboriculture, when a full-grown tree is cut down it is said to be *felled*; but this term is never applied to young trees or bushes, undergrowth, or hedges, which are said to be *rooted out*, or *cut over*. Much has been written respecting the proper season for felling trees; some arguing in favour of midwinter, and others in favour of midsummer. The question principally turns upon the quantity and the value of the soft or outer wood in the trunk of the tree to be felled, known by foresters and carpenters as the *sap*. As this sap or outer wood is the only portion of the trunk in which the sap or juice of the tree circulates, it is evident that if no value be set upon it, the tree may be cut down at any season; because the truly valuable part of the trunk, the mature timber, is impermeable to the sap in its ascent through the soft wood, and is therefore in the same state at every season of the year. On the other hand, where much value is attached to the soft or outer wood, or where, as in the case of comparatively young trees, the greater part of the trunk consists of sap wood, felling ought to take place when there is least sap in the course of circulation. This season is without doubt midwinter, which, all other circumstances being equal, is unquestionably the best season for felling timber; the next best being midsummer, when the sap is chiefly confined to the young shoots, the circumference of the soft wood, and the bark. In general, all the soft woods, such as the elm, lime, poplar, willow, &c., should be felled during winter: hard woods, like the oak, beech, ash, &c., when the trunks are of large size, and valued chiefly for their heart wood, may be felled at any time.

Fellow (Old Eng. felaw, Norse felagi, *a partner in goods*). In the colleges of the English universities, and some other collegiate institutions, the superior members of the foundations are so termed in general. In some, however, all members of the foundation are fellows from their admission. The usages of different foundations in the two universities vary so materially, that no general account will apply equally to all. The fellows are, in general, graduates; and were under the old systems elected either on free competition, or according to limitations fixed in the statutes of foundation. But most of these latter limitations have been abolished at Oxford since the recent reform of that university. Most fellows are obliged to abandon their fellowships if they do not take orders at a certain period: there are, however, lay fellowships in both universities. Fellowships are also vacated in the universities by marriage; and by the acceptance of preferment in the church from the college, or in some instances of other preferment of a certain value. From among the resident fellows are selected for the most part the governing officers and tutors of the colleges. The principal or head of the college is generally elected either by the whole or a select body of the fellows. There is a distinction in some colleges between senior and junior fellowships, in point of emolument, which does not exist in others. At Cambridge there is, or was, also a distinction between foundation fellowships and bye or appropriation fellowships; the former only, in most colleges, entitling the possessor to college offices. The value of fellowships varies greatly; nor do they always maintain the same amount, being generally dependent on corn-rents. The advantages obtained by the fellow are partly in income; partly, if resident, in free lodging and allowances towards board. There are fellowships of the value of 500*l*. or 600*l*. per annum, and others of 100*l*. or less; but a large proportion may be said to average from 150*l*. to 300*l*. a year. *Fellow* is also the general title of members of learned academies and societies in England.

Fellowship or **Partnership.** A rule in Arithmetic, of considerable use in balancing accounts among partners in trade. Considered as an arithmetical process, it is simply a method of dividing a number into parts which shall have given proportions to each other. Fellowship is either simple or compound. To simple fellowship belongs a question of this sort: 'A contribution of 20,000*l*. is levied on three towns, and each is required to pay in proportion to the number of its inhabitants. Now the first contains 2,000 inhabitants, the second 3,000, and the third 5,000; what sum must each contribute?' This question is obviously the same as if it had been required to divide the number 20,000 into three parts, having the ratios of 2, 3, and 5, which is done by dividing 20,000 by the sum of 2, 3, and 5, that is by 10, and multiplying the quotient by each of those numbers separately; the several results are the sums required.

Compound fellowship is when the parts into which the given number is to be distributed are proportional to more than one set of numbers. This is usually called *fellowship with time*, because in distributing the profits of a mercantile transaction carried on by several partners the share of each must be proportional, both to the amount of the capital which he contributed and to the time during which it was employed. It must therefore be proportional to the product of these two. Both cases, it may be remarked, belong to what is more correctly termed *distributive proportion*.

Felo de Se. In Law, one who is found by the coroner's jury to have laid violent hands on himself, or occasioned his own death feloniously.

This verdict occasions forfeiture of chattels, real and personal; but not of lands of inheritance. One found felo de se was formerly buried in the king's highway, with a stake driven through the heart; but since 1823 (4 Geo. IV. c. 52), such bodies are privately buried in a burial-ground, between the hours of nine and twelve at night.

Felony (a word of uncertain derivation. Sir H. Spelman derives it from the word fee or fief, and the Teutonic lohn, *reward* or *price*; that which costs or forfeits land: more probably from the same root with the verb *to fail*). In Law, in the general sense, comprises every species of crime which occasioned at common law the forfeiture of lands and goods. Treasons, therefore, are, strictly speaking, felonies, though in common language distinguished from them. The term *felony* appears, in feudal law, to have been synonymous with forfeiture to the feudal lord. The general punishment attached to felony at common law was death; and if any statute, even now, makes a new offence felony without specifying the punishment, the law implies it to be capital. But some species of felony were not thus punishable at common law; and the gradual operation of altered opinion upon our code has removed this punishment from all but a few. The principal species of felony are: 1. Offences against the person, such as murder, manslaughter, rape, &c.; assault with felonious intent, that is with intent to injure the sufferer in a greater or less degree. The highest of these offences against the person are still punishable by death. The Acts respecting these offences were consolidated by 7 & 8 Geo. IV. c. 31. Some of them, as common assaults, &c., are only misdemeanours. 2. Of offences against property, the great body is comprehended under the ancient appellation of *larceny*. 3. Embezzlement. 4. Burglary. 5. Malicious mischief to property, arson, riotous demolition of churches, chapels, houses, &c., are capital offences within this class. 6. Forgery. 7. Numerous offences of a public nature (many such, however, amount only to misdemeanour): (1) Either against the king and government, as treason, sedition, embezzlement of the king's stores, &c.; (2) Against public justice; (3) Against the public peace; (4) Against public trade; (5) Against public police and economy. Under this head also are to be ranked some offences relative to game, while others come under the description of larceny.

Felsite. A compact variety of Labradorite, which with Hornblende forms the greenstone of Siebenlehn in the Erzgebirge.

Felspar. In Geology, the mineral felspar is the basis of so many rocks, and is distributed so widely in various forms, that it almost ranks as a rock. It is the basis of Trachyte, one of the most important volcanic products, and is not unfrequently met with massive as *felstone* or *felstone porphyry*. The modifications of felspar recognised under these names are metamorphic rocks, but it is not always easy to say whether they are derived from or pass into the condition of the crystalline mineral. Hardly any simple minerals except quartz and limestone are found in such large masses as felspar.

Felspar. In Mineralogy, a name given to several minerals varying much in appearance, and presenting numerous and complicated crystalline forms. They are mixtures of silicate of alumina with silicates of soda, of potash, or of lime, and of other bases. Orthoclase or Common Felspar is of various tints of white and red; it forms an ingredient of granite and other rocks.

The name Felspar is derived from the German Feldspath, or field-spar, which was probably given to it in consequence of the crystals being sometimes found lying loose on the surface of the ground. Kirwan states the derivation of the word to be from fels, *a rock*; from the common occurrence of the mineral in granite.

Felt (Ger. filz). A material formed by interlacing flocks of wool, or hair, without spinning or weaving, so that the texture is spongy and absorbent, until the spaces have been filled up with some substance introduced in the state of a solution, or until the surface has been closed by means of the fulling mill. Asphalted felt is used as a material for temporary coverings or roofs; and a compound of caoutchouc and felt is employed as a kind of floor-cloth.

Felting. The process by which different kinds of fur or wool are blended into a compact texture for the manufacture of hats. The anatomical or structural peculiarities of the different hairs or furs are much concerned in the perfection of the felt; they must be such as to enable them to interlace and intertwine with each other. Hare and rabbit fur, wool, and beaver, are the chief materials used; they are mixed in proper proportions, and are tossed about by the strokes of a vibrating string or bow till they become duly matted together.

Felucca (Span. faluca, Ital. feluca). A small vessel propelled by oars and lateen sails, used chiefly in the Mediterranean and in the adjacent waters for coasting voyages. Before the introduction of steam, feluccas were often used as gunboats, for which the small size and the power of propulsion by oars as well as sails peculiarly fitted them.

Femme Covert. In Law, a term borrowed from the French to signify a married woman.

Femur (Lat. *a thigh*). In Architecture, the interstitial space between the channels of the triglyphs in the Doric order. These femora are sometimes called the *legs* of the triglyphs.

Femur. In Vertebrate Anatomy, the first bone of the leg or pelvic extremity. In Entomology, the third joint of the leg, which is long, and usually compressed.

Fen Lands. Lands, the subsoil of which is constantly in a state of saturation with water, and the surface liable to be overflown by rivers or streams during spring or autumn. The soil of these lands is generally black, light and rich, to the depth of two or three

feet; and as the surface water readily filtrates through it to the subsoil, fen lands generally produce bulky crops of grass and corn. As they seldom have any natural outlet for drainage, this is generally performed by machinery; and when this is the case few lands are more productive. Till lately windmills were employed for draining the English fens; but steam is now frequently used as the moving power, and the advantages to the cultivator are immense: because he can lay his lands dry at the season when it is most convenient that they should be so, whereas the operation of the windmill is always a matter of chance. For an account of the Fens in England, see *British Statistics*; and M'Culloch's *Geographical Dictionary*, art. 'Bedford Level.'

Fence (Fr. défense, as the English *rout* from the Fr. déroute: Wedgwood). Any continuous line of obstacle interposed by art between one portion of the surface of land and another for the purpose of separation or exclusion. The kind of obstacle or material differs according to the animals which are to be separated, excluded, or confined, and the nature of the soil and situation. All fences are either live or dead, or a compound of these. Live fences are hedges; that is, rows of shrubs placed close together, and pruned on the sides, so as to form a sort of living wall. Dead fences are either stone walls, mounds of earth, or structures of wood or of other materials raised above the ground's surface, or open ditches excavated in it. The latter are sometimes filled with water. Mixed fences are those in which some kind of dead fence is used with some kind of live fence; for example, a ditch with a bank of earth on one side, or a ditch with a wall or a hedge on one side: the latter being the commonest of all fences. The introduction of fences into agriculture was about as great an improvement in the progress of that art, as that of the principle of the division of labour into the art of manufacture.

Fend Off. The Sea term for pushing off a boat or any heavy body to break the shock or avoid contact. So also a *fender* is a cushion of yarn, oakum, and rope, inserted between the sides of two boats, or of a boat and any other object, to prevent contact and rubbing.

Fender Pile. A pile fixed in front of a wharf or a river wall, to protect it from abrasion by floating bodies, such as ships, ice, or timber. They need not be carried, therefore, much lower than the water-line, and they are usually made of whole timbers.

Fenestra (Lat. *a window*). In Anatomy, the term is applied to certain holes in the osseous or petrous capsule of the internal organ of hearing; one on the outer wall of the labyrinth, which is filled by the base of the *stapes*, is called the *fenestra ovalis*; a second, at the base of the cochlea, is called the *fenestra rotunda*, and is separated by a membrane from the cavity of the tympanum. [Ear.]

Fenestrate (Lat. fenestratus, *with windows*). In Entomology, signifies the naked hyaline transparent spots on the wings of butterflies.

Fenicuium (Lat. *fennel* or *finkel*). The genus of Umbelliferous plants to which belongs the Fennel and Finnochio. It has finely dissected leaves and yellow flowers; much like *Anethum*, to which it is further allied by its laterally compressed fruit. *F. vulgare*, a wild plant found in dry chalky soil near the coasts, is the Fennel of the gardens, and the fruits both of this and of *F. dulce* yield an aromatic oil.

Fennec (Abyssinian). A species of *Canis*, also termed the Zerda, in which the ears are excessively developed, and whose anatomical structure bears some resemblance to that of the viverrine *Carnivora*.

Fennel. [Fenicuium.]

Fenugreek. The *Fœnum græcum*, a leguminous annual herb, called by botanists *Trigonella Fœnum græcum*, because formerly made into hay in Greece. It was cultivated by the Romans, and is still occasionally met with in the agriculture of the south of Europe. Both the herb and the seeds are strongly scented, the odour indicating the presence of coumarin.

Feoffment. In Law, a species of conveyance. It was in early times the public and solemn mode of alienating lands and tenements in possession, and was performed by a deed, accompanied by livery of seisin; which last was the delivery of the land itself, effected by certain symbolical acts and customary words. As secret conveyances to uses gradually prevailed, feoffments fell comparatively into disuse. The grantor is termed the *feoffor*, and the person receiving the *feoffee*.

Feræ (Lat. *wild beasts*). The name given by Linnæus to the order of Mammalia comprehending those which subsist more or less exclusively on the flesh of other animals. They are characterised by having three kinds of teeth, incisors, canines, and molars; unguiculate extremities, without an opposable thumb on the fore foot, but with the power of rotation in the forearm. This order corresponds with the *Insectivora*, and the Plantigrade, Digitigrade, and Pinnigrade *Carnivora* of Cuvier's *Carnassiers*.

Feræ Naturæ (Lat. *of wild nature*). In Law, a term applied to animals, such as foxes, wild ducks, &c., in which no one can claim property.

Fergusonite. In Mineralogy, a crystallised compound of columbic acid and yttria with a small quantity of zirconia, and of oxides of tin, cerium, iron and uranium. It has hitherto been found only in Greenland.

Feriæ (Lat.). In Roman Antiquities, solemn religious festivals. The most celebrated were the Feriæ Latinæ (Latin holidays), celebrated on the Alban Mount by all the states of Latium in common. This festival is said to have been originally instituted by the second Tarquin. At first it lasted for one day only; but in process of time it was extended to four. It was observed by the consuls regularly before they set out for their provinces.

Ferines (Lat. ferinus). The English equivalent of the *Carnassiers* of the system of Cuvier; but generally employed to designate the group corresponding with the *Feræ* of Linnæus, and excluding the bats (*Cheiroptera*), which form the first family of Cuvier's *Carnassiers*.

Fermat's Theorem. One of the most important in the science of Arithmetic. Its discoverer, Fermat, is said to have been in possession of a proof (*Fermati Opera Mathematica*, Tolosæ 1679), though Euler was the first to publish its demonstration (*Comment. Arith.* Petropoli 1849). The theorem is susceptible of two equivalent enunciations: First, If p be a prime, the $(p-1)^{th}$ power of every number prime to p will, when diminished by unity, be exactly divisible by p. Thus 25^6-1 is exactly divisible by 7. Thus enunciated, Fermat's theorem may be regarded as the fundamental proposition of the arithmetical theory of the residues of powers. Secondly, The binomial congruence $x^{p-1}\equiv 1$ (mod. p) has always $p-1$ incongruous roots when p is a prime number. The congruence in question, therefore, has its maximum number of roots [CONGRUENCE], which latter constitute, of course, a complete system of residues prime to p. It is from this point of view that Fermat's theorem may be justly regarded as the basis of the whole theory of congruences.

Amongst the demonstrations of the theorem which have appeared since the one above referred to, those most esteemed were given by Lagrange (*Mém. de l'Acad. de Berlin*, 1771), Dirichlet (Crelle's *Journal*, vol. iii.), Binet (*Jour. de l'École Polytech.* cah. xx.), and Poinsot (*Réflexions sur la Théorie des Nombres*). Euler's first demonstration is a very simple one, and is the one generally given in elementary treatises on the subject.

Another theorem, distinguished as *Fermat's last Theorem*, has obtained great celebrity on account of the numerous attempts that have been made to demonstrate it. The theorem asserts that $x^n+y^n=z^n$ is irresoluble in integers for all values of n greater than 2; and although it was enunciated by Fermat two centuries ago, no complete demonstration has yet been given. The least incomplete demonstration was given by Kummer in Crelle's *Journal*, vol. xl., and Liouville's *Journal*, vol. xvi. The theorem has been established, at all events, for all exponents up to 100.

Ferment (Lat. fermentum, from ferveo, *I boil*). The substance which is essential to the process of fermentation. It is either naturally present in the fermentable juice, as in the grape; or it is added, as in the manufacture of beer, where *yeast* constitutes the ferment. Ferments are of an albuminous or glutinous character: the presence of nitrogen seems essential in their composition; hence they are classed by chemists among azotised compounds. Their modus operandi is still unexplained.

Fermentation (Lat. fermentatio). By fermentation, we understand the conversion of an organic substance into new compounds, in presence of a *ferment*. Hence there are various kinds of fermentation, designated according to their products. In *vinous fermentation*, sugar, or any substance capable of being easily converted into sugar, is resolved into carbonic acid and alcohol, 45 parts of sugar yielding 22 of carbonic acid and 23 of alcohol. But pure sugar, dissolved in pure water, has no tendency to undergo this remarkable change, except under the influence of a nitrogenous principle called a *ferment*. It was observed by Gay Lussac that when fresh grape-juice was collected in a vessel containing carbonic acid, no fermentation took place, although all other circumstances were favourable to this process. When, however, the juice was exposed to air and a proper temperature, it rapidly fermented, and when once this fermentation had commenced, it continued until the saccharine matter was decomposed. There appears, therefore, to be present in grape-juice a substance which by contact with oxygen becomes a ferment; and further, that the saccharine juice of the ripe grape does not ferment, because the access of free oxygen is cut off by the epidermis of the fruit.

In the process of *brewing*, the fermentation of the *sweet wort* is accelerated by the addition of a ferment in the shape of *yeast* or *barm*, which occasions the rapid conversion of the saccharine matter of the wort into alcohol and carbonic acid, and tends at the same time to the formation of new yeast.

It has been shown by Mitscherlich, that the actual contact of the particles of the yeast with the dissolved sugar is essential. He suspended a wide glass tube, the bottom of which was closed with bibulous paper, in a jar of a solution of sugar, the tube being itself filled with the same solution. Some yeast was then put into the syrup contained in the tube, where it soon induced fermentation, and the alcohol there formed passed through the pervious bottom, and, together with carbonic acid, diffused itself in the surrounding liquor: but the actual phenomena of fermentation—namely, the decomposition of the sugar and the formation of alcohol and of carbonic acid—were limited to the syrup in the tube containing the ferment, while the sugar in the outer vessel remained unchanged.

Quevenne found that yeast which had been deprived of all matter soluble in water, still retained its power of exciting fermentation, and that the active part of yeast is composed of minute vesicles or globules, which during fermentation germinate in the saccharine liquor. According to Andral and Gavarret (*Ann. Ch. et Ph.*, 3ème sér., viii. 399), there are two species of germs contained in yeast, which may be separated by diluting it with water: in a few days globules fall to the bottom of the vessel, forming a grey pulverulent deposit which is extremely active in producing alcoholic fermentation; but at the same time a film forms upon the surface of the liquid, which consists of germs (of *Penicillium glaucum*) having no such

power: these latter germs become *filamentous*, while the true producer of alcoholic fermentation always retains its *globular* form. According to Mitscherlich, the active part of yeast which remains after it has been washed with water, consists of: Carbon, 47·0; hydrogen, 6·6; nitrogen, 10·0; oxygen, 35·8; sulphur, 0·6.

Of this yeast (in the dry state) from two to three parts are required for the decomposition of one hundred parts of sugar; and if there is excess of sugar, it remains unchanged after the fermentation. That portion of the yeast which remains in the form of a deposit after fermentation is over, and which is inefficient as a ferment, appears, when examined under the microscope, to consist of the ruptured cells, and is not susceptible of vegetation; so that during the fermentation of sugar, a certain portion of the yeast-plant dies, and is decomposed, the living plant being required to sustain the fermentative process. If more yeast be present than is required for the decomposition of a certain quantity of sugar, the deposit which is in that case formed, consists partly of broken and partly of entire cells, and the latter retain their power of inducing fermentation. It further appears that that portion of the yeast which has become inert as a ferment, has lost the greater part, if not the whole, of its nitrogen; and one of the results of the changes which ensue during saccharine fermentation appears to be the formation of ammonia, traces of which may be detected amongst the gaseous products.

What is called *German yeast* is yeast which has been washed and dried at a low temperature. It is chiefly obtained from the distilleries of Holland, and is largely imported into England. Boiling water destroys the fermenting properties of yeast; but unless boiled so long as to have its chemical nature entirely changed, it reacquires a fermenting power on exposure to air.

Sugars differ in the readiness with which they undergo fermentation. Pure cane-sugar (*sucrose*, $C_{12}H_{11}O_{11}$) does not readily ferment; grape-sugar (*glucose*, $C_{12}H_{14}O_{14}$) is easily fermented, but the process takes place most readily in fruit-sugar (*fructose*), represented by $C_{12}H_{12}O_{12}$. And it is probable that both cane and grape sugar pass into fruit-sugar before they undergo the change. When fermentation is complete, 100 parts of fruit-sugar are resolved into 51·12 of alcohol and 48·88 of carbonic acid, so that the ferment adds nothing to and removes nothing from the elements of sugar. Vital, chemical, and dynamic hypotheses have been proposed to account for the modus operandi of the ferment in effecting the changes, but as yet we remain ignorant upon this subject.

Fern Root. The root of the *Aspidium Filix mas*, or male fern. About two drachms of the dried root, in powder, followed up by a brisk purge, is occasionally given as a vermifuge. It was Madame Nouffer's celebrated specific.

Ferns. [FILICES.]

Feronia. In Botany, this name of an Italian deity (akin to Tellus) is given to the Wood-apple or Elephant-apple of India, *F. elephantum*, a tree which belongs to the order *Aurantiaceæ*. A transparent gum, sent to this country as East Indian gum arabic, flows from the trunk when wounded; and the fruit, which has a pulpy flesh, has a beneficial action in cases of dysentery and diarrhœa.

Ferret. [MUSTELA.]

Ferric Acid. An unstable teroxide of iron, not known in the free state: it is formed in combination with potash.

Ferricyanogen or **Ferridcyanogen.** A compound of two atoms of iron and six of cyanogen, which, in combination with three atoms of potassium, forms the *ferridcyanide of potassium*, or *red prussiate of potash*.

Ferro-hydrocyanic Acid. A compound of three atoms of cyanogen, two of hydrogen, and one of iron. It is the *ferro-chyazic acid* of Mr. Porrett, the term *chyazic* being composed of the initials of carbon, hydrogen, and azote, which are the ultimate elements of hydrocyanogen.

Ferrocyanogen. A compound of one atom of iron and three atoms of cyanogen; or one of iron, six of carbon, and three of nitrogen; in combination with two atoms of potassium, it constitutes *anhydrous ferrocyanide of potassium*, the crystals of which include three atoms of water. This crystallised ferrocyanide of potassium is generally known under the name of *yellow prussiate of potash*.

Ferrugo. In Botany, a disease of plants, commonly called *rust*. It is caused by the presence of myriads of the minute parasitic fungus called *Trichobasis Rubigo vera* (formerly *Uredo*), and one or two allied species, of the order *Pucciniæi*. While confined to the leaves, it does comparatively little injury; but it becomes formidable when it attacks the chaff and seed. It generally accompanies over-luxuriance.

Ferry (Ger. and Sax. fahren, *to pass over*). In Law, a right arising from royal grant or prescription to have a boat to carry men and horses across a river, and to levy reasonable toll. The land on both sides ought to belong to the owner.

Ferula (Lat.). A genus of Umbelliferous plants with yellow flowers, and thin flat fruit resembling that of the parsnip. The species are chiefly natives of Persia and the Mediterranean region. The plant from which the principal supply of Assafœtida is obtained, formerly included in *Ferula*, is now referred to *Narthex* [NARTHEX]; but *F. persica*, a smaller plant than the foregoing, is said to yield some portion of it. From *F. orientalis* and *F. tingitana* is obtained African ammoniacum. [AMMONIACUM.] Many of the species are handsome plants, with very large leaves divided into an infinite number of small variously shaped segments, and producing tall stems which bear large umbels of yellow flowers. They are called *Giant fennels* in gardens.

Fescennine Verses (so called from Fescennia, an Etrurian town, where they first had their origin). In Roman Antiquities, rude extemporaneous pieces of poetry recited by the youth of Latium and Etruria at rustic festivals.

especially at harvest home, with gestures adapted to the sense. They consisted principally of raillery and playful rustic abuse, and are chiefly remarkable as having given rise to Satire, the only class of poetry of native Italian growth. [SATIRE.]

Fescue Grass. A valuable grass for meadows and pastures. In deep rich soils somewhat moist, *Festuca pratensis* is considered one of the most bulky and nutritive of all grasses; but in poorer soils it is equalled, if not surpassed, by the rye grass (*Lolium perenne*) and the meadow foxtail grass (*Alopecurus pratensis*). The meadow fescue grows to the height of between two and three feet; but the sheep's fescue (*F. ovina*) and several other species seldom grow above a foot in height, and are chiefly sown on sheep pastures, and used to lay down lawns and grassy surfaces to be mown in pleasure grounds. All the cultivated fescues are perennials, and most of them natives of Britain. *F. heterophylla*, *Halleri*, and *valesiaca* are among the foreign species which are cultivated for their produce.

Fess (Lat. fascia, *a wide belt*). In Heraldry, one of the ordinaries. It is bounded by two horizontal lines across the escutcheon, equally distant from the *fess point* or centre of the escutcheon. A fess not reaching to the sides of the escutcheon is said to be *couped* (cut) or *humetty*. The diminutives of the fess are the *bar*, the *closet*, and the *barulet*. A fess with a barulet on each side of it is said to be *cotised*. A fess removed to the top of the escutcheon is termed a *chief*, and held to be an honourable augmentation.

Festoon (Fr. feston). In Architecture, a carved representation of a wreath or garland of flowers, or leaves and fruit, or of all of them interwoven together; they are thick in the centre, and diminish gradually towards each extremity, where they are fastened, and often turned over.

Fetials. [FECIALS.]

Fetich or **Fetichism.** The word *fetich*, said to be derived from the Portuguese, appears to have been brought into common usage by the writings of some travellers on the western coast of Africa. It is now comprehensively employed to signify any object of worship not representing a living (or rather perhaps a human) figure; thus excluding idols, properly so called. Fetichism is the worship of material substances, and prevails very extensively among barbarous nations, and especially those of the negro race. Among the latter, tribes, families, and individuals have their respective fetiches; which are often objects casually selected, as stones, weapons, vessels, plants, &c. &c. [OBEAH.]

Fetlock (quasi *footlock*, whence the derivation). In the *Manége*, a tuft of hair growing behind the pastern joint of horses; hence the joint where it grows is called the *fetlock joint*.

Fettered. In Zoology, a term applied to the feet of animals when they are stretched backwards and appear unfit for the purpose of walking; or when they are concealed within the integuments of the abdomen.

Fettstein (Ger. *fat stone*). [ELAOLITE.]

Feu (Lat. feodum, *fief*). In Scottish Law, is used in contradistinction to *ward-holding* or military tenure, to signify that holding where the vassal makes a return in grain or money in lieu of military service. The *feu contract* is that which regulates the giving out of land, as between superior and vassal; the rent paid being termed the *feu duties*.

Feudal System. A body of institutions of a peculiar character, introduced into Europe by the German and Gothic tribes, which prevailed for a long period, and has left important traces of its existence in most European countries. The words *fief* and *feud* are both, it is conjectured with much probability, corruptions of the Græco-Latin term *emphyteusis* (pronounced emphytefsis), signifying a contract whereby an individual acquired the enjoyment of a piece of land without the absolute property in it. Hence by contraction came *fef* or *fief*, and by the addition of a neuter termination *fevodum*, *feudum*, *feodum*. Another derivation, recently suggested, is from the Irish *fuidhur*, *fuidh*, signifying, in the Brehon Laws, a stranger who enjoys land within the domains of a clan, and the tenure by which he enjoyed it. The English word *feud* (quarrel or strife) is of an entirely distinct origin, being the same with the German *fehde*. The German equivalent for *fief* is another original word, *lehn*.

It is clear that feudal usages were absolutely unknown to the ancient Romans; but among that people, and especially in the later times of the empire, there existed certain customs which were analogous in appearance, although not in origin—such as the establishment of military colonies on the frontier, where the tenant of land was a soldier, and liable to be called into active duty; and the cultivation of great part of the empire by *coloni*, a distinct class of men, raised above the condition of the slave, and yet bound to render services to the proprietor, and in some instances annexed to the soil. The barbarians therefore in many instances adapted the conventional language and the laws of Rome to their own native customs; thus producing a confusion of idiom and practice, of which a better instance cannot be found than the fact already mentioned, that the word *feud* itself is derived from a legal term of the Greek empire.

The immediate result of the conquest of Gaul, Italy, and Spain by the various barbarian tribes, was the division of the lands (except such portions as were left in the possession of the Roman cultivators and only rendered liable to tribute) between all the armed men of the nation. The shares were undoubtedly unequal even in the earliest of these divisions; but however differing in point of wealth, all the free proprietors were equal in rights: all were held liable to serve with the national force when called into the field; all had a voice, at least nominally, in the making of laws and in the choice of a sovereign. These free citizens are

called by various names in the legislation of the different tribes; the Lombard title of *arimannus* (ehren-mann, *man of honour*, or heer-man, *warrior*) seems to have been the most permanent. Such, however, was the general constitution of the kingdoms of the Lombards in Italy; the Franks in Gaul; the Visigoths, Ostrogoths, and Burgundians; and of the various states which grew up within the limits of Germany itself, after the confusion occasioned by the great migrations had passed away.

The decay of these aristocratic republics was brought about by nearly the same causes which operate in undermining all systems founded on equality of rights and classes. The constant wars and vicissitudes to which these governments were subject naturally raised up among the citizens some more powerful than the rest, and converted a great body of the freemen into dependants upon these. The dukes, counts, and other great men, became the actual controllers of the community: the free citizens, wherever unable to associate for mutual protection, were subject to innumerable vexations. From the earliest times, and before the fall of the Roman empire, it had been customary among the Germans for the princes and chief men to be attended by a select body of faithful companions, whose dependence on them, and services due to them, were recognised and fixed by general usage. This custom, under the new circumstances of the Germanic and Gothic kingdoms, acquired peculiar force. It became an object of ambition to the chieftains to have as many dependants as possible. With this view, every species of vexation was exercised by them towards the unprotected arimannus, to induce him to abdicate his own independence, and enroll himself under their command. During the wars and confusions of the eighth and ninth centuries, the foundations of the feudal system were laid by this personal dependence assuming gradually the character of a territorial dependence also. The arimannus was induced to surrender up his free or allodial lands to the king or count, and became his *liegeman* (fidelis), *antrustion* (our English word *trust* comes from the same source), *vassal*, or *man* (homo, whence *homagium*, homage), receiving back his lands to hold of the superior. This process can only now be traced by insulated documents and historical facts; but, arising out of the same circumstances in most countries of Western Europe, it took in all of them nearly the same course. It is ably developed by Hallam (in his first chapter on the *Feudal System*), and Meyer (*Institutions Judiciaires*, livre i.).

The success and energy of Charlemagne arrested for a time the decomposition of the old society; his empire extended over nearly all those portions of Europe which afterwards became feudal; and his various laws (in the end of the eighth and beginning of the ninth century) present a remarkable picture of what may be called the state of transition from the allodial to the feudal system. We find in them that the free proprietors, or arimanni, still formed a very numerous body; and that the exigencies of military service fell most heavily upon them. They were obliged to serve at their own cost; while the counts, &c. brought their vassals to the field at their own expense. These laws are full of the vexations endured by the former class from the powerful military chieftains. On the other hand, the practice of attaching individuals to the person of the sovereign or superior by the grant of lands (*benefices*), and the obligations imposed on the inferior by the grant, are clearly developed. The distinction between lands *allodial* (held in *franc aleu* without feudal superior) and *feudal* lands (though the latter term was not yet used) is as marked as at any subsequent period. But benefices were not yet hereditary: and it is doubted by the most learned writers, whether they were generally or frequently precarious and revocable, or not.

The decay of Charlemagne's empire, and the disasters of the two centuries which followed his reign, completed the formation of the feudal system. The great step by which that change was completed was when the benefices or fiefs became, like the former allodial properties, hereditary. There can be little doubt that this change was merely the result of those disastrous circumstances of civil and barbarian wars which during that period relaxed the slight bonds of the Carlovingian monarchy, and rendered every man as far as possible dependent on an immediate superior, and independent of a central authority. The earliest express creation of an hereditary fief is considered to be the donation of the duchy of Aquitaine to Eudes and his heirs by Charles-le-Chauve. The great vassals established their families permanently in the lands which they held of the fisc or royal domain: their liegemen, in turn, were gratified by acquiring the same right in their own subordinate fiefs. There can be no doubt that the nobility of modern Europe owes its origin, in general, to nearly the same period and the same causes: those families which succeeded in acquiring extensive fiefs, and preserving them for several generations, became noble by prescription. In the meantime, the arimanni, or allodial proprietors, found that their condition became worse from generation to generation: they were loaded with services and dues until, in the tenth century (as is shown by Meyer) the term *arimannia* became synonymous with exaction. But although the feudal system became so generally prevalent, that the maxim 'Nulle terre sans seigneur' (importing that lands were presumed feudal until the contrary was shown) became generally received, yet in France and Germany the allodial proprietors never became wholly extinct. In some districts of the former country the maxim was reversed, and lands were presumed allodial (*Hallam.*)

The law of Conrad, the Salic, in Lombardy (1039), contains all the main features of feudalism: the *Assises de Jérusalem* and other compilations show, that in a century more it had

been invested with all the refinements of a legal system.

By the principles of this system, the king was, in the last resort, proprietor of all the feudal lands of his kingdom. Those who were enfeoffed of lands directly from the crown, and owed homage and service to the king, were termed *tenants in chief* (in capite), &c. These, again, enfeoffed other inferior tenants, who held immediately of them; and this practice (called *sub-enfeudation*) might be carried on through several gradations. Thus the same individual was a *vassal* or dependant of the crown, and *lord* or *suzerain* with reference to his own vassal who held of him, also termed *mesne* or mediate lord, a term which comprehended both these relations. But although all perfect fiefs resembled each other in their theoretical character, and particularly in their great attribute of military service; yet, in point of fact, tenants holding immediately of the crown stood in very different degrees of subordination. Thus, in France, the great vassals (the dukes of Normandy, Brittany, &c.) were immediate tenants of the crown, but in effect almost independent of it; while they exercised much stricter sovereignty over their own immediate tenants. But other lands, being the demesne of the crown itself, were held of it by lesser tenants in chief, who stood to the king in the same close relation as the vassals of the great feudatories did to them. Thus the government of France, at the period when the feudal system was in greatest vigour, was that of a collection of independent sovereigns, of whom one, the king, had a certain supremacy over the rest, but each, within his own domains, exercised an equal authority: and such was, in theory at least, the constitution of every feudal kingdom. The ceremonies used in conferring a fief were chiefly three: 1. *Homage*, by which the vassal owned the lord's supremacy; but *homage per paragium*, or simple homage, was unaccompanied by any feudal obligation; *homagium ligeum*, or liege homage, implied such obligations: the former only was rendered to the king by the great feudatories above mentioned. (Hallam's *Middle Ages*, ch. ii. part i.) 2. The oath of *fealty*. 3. *Investiture*, or the conveyance of feudal lands, actual or symbolical. The chief *obligation* of a feudal tenant was military service; but the laws which regulated this essential part of the contract were so various, that it is not possible to give any comprehensive description of them. In some places every tenant was obliged to serve personally for his fief, whether large or small; in others (as England), the land was divided into a certain number of equal parcels, from each of which a soldier's service was due: the term of service was also variously regulated by custom. The conflicting rights of superior and inferior lords to the vassal's military service were also never satisfactorily adjusted. When feudality was in its most flourishing state, he commonly followed the banner of his immediate superior, even against the crown; but with the progress of the royal power, his obligations were gradually transferred to the king as lord paramount: military service was in most cases rendered commutable, in process of time, for an amercement in money. [ESCUAGE.] There were other inferior obligations which attached to the military tenures, commonly called *feudal incidents*. These were chiefly: 1. *Reliefs*; i. e. sums of money paid to the lord by tenants of full age on taking fiefs by descent. 2. *Fines* upon alienation, which were sums paid on alienating a fief; a privilege which was only gradually acquired by feudal tenants, being contrary to the principles of the institution. 3. *Escheats*; i. e. the reversion of the fief to the lord, on failure of the tenant's heirs or forfeiture. 4. *Aids*; sums paid by tenant to the lord, on certain specified occasions. And to these may be added the feudal rights of *wardship* (by which the lord, in some countries, had the custody of his tenant's person, and the enjoyment of his lands until he was of full age) and *marriage* (by which the lord had the right of disposing of such ward's land in marriage, or, if the marriage were rejected, to a sum of money equivalent to the marriage, i.e. as much as it was presumed the party seeking the marriage would have given the lord for the alliance). Forfeiture of the fief to the feudal lord was incurred by the tenant's violating any of the original conditions of fealty, homage, and military service. But the vassal was protected from the unjust aggression of the lord by that which seems to have been an inherent and necessary condition of the feudal system; the judgment, namely, of his peers, without which such forfeiture could not be incurred—supported by the right of private warfare, which in the last resort was the resource both of the lord to enforce obedience from the vassal, and the vassal to protect himself against his equal or his superior. On failure of heirs, the fief fell or escheated to the lord. Fiefs holden by military tenure were, strictly, *proper* fiefs. There were also a great variety of tenures by rendering particular stipulated services, created, for the most part, in comparatively late times, which were also deemed feudal in their character, and constituted *improper* fiefs; such were, especially, tenures by the performance of menial or other personal services, from which arose the English *Grand Serjeanty*. [SERJEANTY, GRAND AND PETTY.] All these tenures were of a higher or noble character; but in some countries large portions of the land were held either immediately of the king, or mediately of feudal lords, by base or inferior tenures. Such lands were styled *fiefs roturiers* in French jurisprudence; in English, this class of tenures was comprehended under the common term of *socage*, which comprised both tenures in *free* or common socage, and those in *villein* socage, from which are derived tenures in *ancient demesne*. [SOCAGE.]

The division of ranks under the feudal system corresponded in theory, although not precisely in practice, to the territorial division of lands according to their tenures. Those who held their fiefs by knight-service were the original

nobility of the soil; nor has the class of gentry, in most countries, any other origin. The bearing of arms, the distinctive character of surnames, &c. &c., became afterwards, in course of time, the distinctive marks of the class of nobility, which no longer adhered so closely to the soil from which it sprang. Thus in France we find that a noble might, in later times, hold a fief roturier, while a roturier might hold a proper fief; although, in such a case, services such as were rendered by the gentry were of course commuted. But it may be in general observed, that almost the whole soil of France, north of the Loire, was under noble tenures; in the south only were free tenants, not noble, a numerous class. In many parts of Germany the distinction between *adeliche güter* (noble fiefs) and *bauer güter* (peasant fiefs) has been only recently effaced, or still subsists: in Prussia it was abolished in 1807. In England the course of the feudal system was somewhat different; the class of free tenants in socage was far more numerous and influential: hence the yeomanry of England formed a body of men to which a parallel could hardly be found in any other country. The burgesses, or inhabitants of towns, constituted in feudal realms a class apart; and their communities were either really, or by fiction, emancipated by royal charters from the tenure by which they were supposed to hold their land either of the king or some mesne lord. Lastly, the lowest class of the population consisted of serfs or villeins, attached to the soil in many instances; but whose state varied so greatly under different circumstances as to render it impossible to give any general description of their condition.

Such is a very brief and general outline of the complicated system of rights and duties which bears the historical name of feudal. It is necessary, however, to add, that this system assumed very different shapes in the different countries in which it prevailed. France was the country in which feudalism had, if not its origin, at least its greatest extension, and was most nearly reduced in practice to its theoretical form. Up to the fall of the Carlovingian empire, that country must be regarded as an aggregate of provinces, inhabited by different nations, and governed by a variety of laws, but acknowledging the sovereignty of a monarch whose power was more or less obeyed, according to his own personal talents and other casual circumstances. After the separation of France and Germany by the treaty of Verdun in 843, a succession of feeble princes and the invasions of the Normans almost broke up the slender frame of the French monarchy. The governors or masters of extensive provinces, who had by this time secured to themselves the hereditary sovereignty of their respective benefices, became independent within their own limits: when feudal royalty was continued under the Capetian kings, these ranked as the great vassals of the crown. Their powers have been classed by Mr. Hallam under five heads: 1. The right of coining money; 2. That of waging private war; 3. The exemption from all public tributes except the feudal aids; 4. The freedom from legislative control; and 5. The exclusive exercise of original judicature in their dominions: of these, the fourth was the most characteristic of the French system. No general legislative power, vested in an assembly of the nation, seems ever to have existed in France as a whole. This circumstance, which in the first instance seemed to the great vassals a security for their independence, proved in the end the cause of their decay; as, with the gradual increase of the royal powers, the legislative authority of the king himself, in the absence of any recognised national council to assist him, acquired continually increasing force. Meanwhile, the extraordinary power of the great vassals in France in some degree weighed down that of the inferior nobility: the ties of feudal subjection, weakened in the highest relation (i. e. between the great vassals and the crown), were much stronger between the great lords and the lesser barons, chatelains, or vavassors, who depended on them. The king, according to the establishments of St. Louis, could not declare any new law in the territory of his baron without his consent, neither could the baron in that of his vavassor; but, in a partial point of view, the king and the baron, within their respective demesnes, exercised a much more real sovereignty than that which the former possessed over the latter. It was about the reign of Philippe-le-Bel, in the beginning of the fourteenth century, that the feudal system, which had lasted up to that time from its establishment in the tenth without material innovation, was in effect overthrown, and the king of France began to be in reality master of his kingdom. This change was chiefly brought about by the extension of the king's juridical power by means of the parliaments; and lastly by the convocation of the States-General, as the representative body of the whole nation. The greater fiefs were reannexed in the course of events to the crown, with the remaining power and privileges of their lords.

There can be no question that feudal principles prevailed to a considerable degree in the polity of the Saxons in England; but when that country was conquered by the Normans, the latter imported with them the entire system, already invested (in the eleventh century) with a legal and regular character. Hence, while feudalism grew up from the circumstances of society in France, it may be said to have been transplanted, as to most of its details, into England from a foreign soil. The land was parcelled out, as in France, between higher feudatories and inferior tenants holding of them by knight-service. But two circumstances chiefly produced the very different shape into which the system ultimately resolved itself: 1. The existence of the great body of freemen of Saxon descent, who were neither reduced into villenage, nor deprived of their lands, nor yet ennobled by being ranked

along with the Norman military tenants. 2. The permanent national council, which seems to have been everywhere a peculiarity of the Norman system of government, and which, by taking cognisance of matters pertaining to the general interests of the realm, at once controlled the power of the king and that of the great barons as single and independent chiefs. Thus the country remained, even in the most troubled period of the Plantagenet dynasty, in constant union under some central authority; and the feudal principles were modified, both by the common law of the land, and also by various statutes, of which that commonly styled by its first words 'Quia Emptores,' passed in the reign of Edward II., which put an effectual stop to all further *sub-enfeudation*, was perhaps the most effectual.

In Germany, as well as France, the feudal usages seem to have grown into a system under the sovereignty of the Carlovingian emperors. But in that country, owing, perhaps, partly to the constant danger from foreign invasion on the eastern side, which kept the people more together under the central authority, the sovereigns never lost, during the dark period of the ninth and tenth centuries, so much of their power as those of France. Hence the greater vassals did not acquire such complete independence; but when, after the eleventh century, the elective character of the empire was more fully recognised, the imperial power decayed; and that of the vassals rose during the period in which the contrary progress was taking place in France. And as the inferior barons had not been depressed, as in the latter country, by the overgrown power of the superior, Germany presented the example of a country in which the feudal system was carried out more completely, and for a greater length of time, than in any other; nor is there any in which the frame of society, to the present day, shows so many relics of its long predominance.

In Italy the feudal system, under the Carlovingian government, was widely prevalent. The chief cause which in that country weakened and brought it to decay, or rather prevented its complete establishment, was to be found in the power and independence of the large towns, which at first effectually resisted, and afterwards broke down, the strength of the nobility.

In Spain, feudal tenures were of late introduction, and were very partially known, except in the kingdom of Arragon.

In the northern and eastern kingdoms of Europe (Sweden, Denmark, Hungary, Bohemia) they were never introduced at all, except in some few instances, and in these wholly without general effect.

Feuillæa (named after Louis Feuillée, a traveller in Chili). Climbing tropical American *Cucurbitaceæ*, one of which, *F. cordifolia*, is the Sequa or Cacoon antidote of Jamaica, regarded by the negroes as effective in cases of poisoning, probably for its purgative and emetic properties. The seeds of an allied species, called Abilla in Peru, contain so much oil that the natives make rude candles by cutting cubical pieces of the seeds and stringing them on a thin stick, the point of which is lighted.

Feuillans. In Ecclesiastical History, a religious order, an offset from that of the Bernardines, established A. D. 1577, at the convent of Feuillant in Languedoc. The *Club des Feuillans* in the French Revolution was composed of moderates who receded from the Jacobins in 1791, and held their meetings in the convent of this order; it was extinguished in 1792.

Fever (Lat. febris). A disease in which one of the most general symptoms is increased heat of the body. The temperature is often actually higher than it should be; and the sensations of heat, dryness, and even burning of the skin, are often excessive, independent of any proportional increase of thermometric heat. The subject of fever has given rise to endless medical discussions and theories; and the definitions of the disease, given by different writers, are not less varied than numerous. In fevers there is generally great constitutional derangement, unaccompanied by local or perceptible organic disease. Fevers generally begin with languor of body and mind; chilliness, amounting to shivering, though the skin often at the same time feels hot; the pulse is quicker than it should be; respiration hurried or laboured; pains are complained of in various parts, and especially about the head, back, and loins; the appetite falls off, or there is nausea and vomiting; the mouth is dry; the bowels generally irregular: and the urine small in quantity and deep in colour. These, which constitute the first stage of ordinary febrile symptoms, are succeeded by flushings, a quicker pulse, and by mental anxiety and wandering, which, under many aspects and modifications, constitute the second stage: they are succeeded by the third stage, in which the leading appearances are a cleaner tongue, a more natural pulse, a moist skin, calm mind, the urine becoming more copious in quantity, and depositing a sediment as it cools. The symptoms of fever generally undergo an increase every evening, which is called an *exacerbation*; and this fluctuation often takes place more than once in the twenty-four hours, the violence of the attacks increasing with their occurrence, and forming what is called a *continued fever*. After some days, a *crisis* takes place; that is, the symptoms either take a favourable or an unfavourable turn. If the exacerbation and remission of symptoms are well marked, and occur once or oftener in the day, the fever is called a *remittent*; if the fever leaves the patient after some hours' duration, and returns at stated intervals, it is called an *intermittent*. [AGUE.] Fevers are also variously denominated, according to the characteristic symptoms, as *inflammatory*, *typhoid* (sometimes called *gastric* or *intestinal fever*), *relapsing fever*, and *typhus* or *putrid*, *nervous fever*, &c., or according to cutaneous appearances connected with them, such as *scarlet fever* and *yellow fever*.

Fiacre. The French name for a hackney-coach, so called as having been introduced by Sauvage, who lived in the Hôtel S. Fiacre.

Fiars. A word of Gothic origin, signifying, in Scotland, the prices of grain for the current year in the different counties, fixed by the sheriffs respectively in the month of February, with the assistance of juries. The form of striking the fiars, says Mr. Bell, in his *Law Dictionary*, is prescribed by the Acts of Sederunt, Dec. 21, 1723, and July 29, 1728. A jury must be called, and evidence laid before them of the prices of the different grains raised in the county; and the prices fixed by the opinion of the jury, and sanctioned by the judge, are termed the *fiars* of that year in which they are struck, and regulate the prices of all grain stipulated to be sold at the fiar prices. The fiar prices also regulate the price in contracts concerning grain (the product of the county) to be delivered, and where no price has been otherwise agreed upon between the parties. This method of ascertaining the prices of grain, &c. in each county has greatly facilitated the introduction into Scotland of the practice of letting land for corn rents convertible at the prices of the day. A similar system has been long pursued in England in the returns of the highest prices at which wheat and malt are sold at Michaelmas and Lady-day. This custom dates from 1582, and was established by an Act of that year, which provided that a certain portion of reserved rents should be paid in corn, or at corn prices. The Act was passed, we are told, at the instance of Burleigh, who, seeing the gradual depreciation of money, determined to arrest the fall in the real value of reserved rents, especially those enjoyed by corporations, by the stipulations mentioned above, wheat and malt being taken as sufficiently indicating corn values. It is from these sources that information as to prices of corn in successive years has been derived continuously since the date of the statute. The Oxford and Windsor prices have been published by Mr. Lloyd, sometime Professor of Political Economy in Oxford, and there is no doubt that similar records may be discovered in the archives of such corporations as the colleges in Cambridge and ecclesiastical chapters throughout England.

Fiat (Lat. *let it be done*). In Law, a short order or warrant of some judge for making out certain processes, &c.

Fibre (Lat. fibra). In Botany, one of the two bases of all vegetable structures. It may be compared in fineness to a hair, its diameter often not exceeding $\frac{1}{1200}$ of an inch. The finer divisions of roots are also denoted by this term.

Fibrillæ. In Botany, the minute subdivisions of the root, each being a small bundle of annular ducts, or sometimes of spiral vessels encased in woody tissue covered by cellular integument, and in direct communication with the vascular system of the root. The apex is composed of lax cellular tissue.

Fibrin. A term applied to the muscular fibre when cleansed by washing from all adhering impurities; or to the coagulum of the blood when the whole of the serum and colouring matter is washed out of it. It is whitish, insipid, and inodorous, and contains about 20 per cent. of nitrogen, nearly 2 per cent. of sulphur, and a trace of phosphorus.

The term *vegetable fibrin* has been applied to a modification of *gluten*.

Fibrolite. A mineral, analogous to Kyanite, of a fibrous texture, accompanying *corundum*, from the Carnatic and from China.

Fibula (Lat. *that which serves to fasten*). A long slender bone of the leg, placed upon the outer side of the tibia, the lower end of which forms the external ankle.

Fichtelite. A white crystalline substance found in a peat moss in Bavaria: it is a hydrocarbon $= C_{20}H_{16}$, isomeric with oil of turpentine.

Ficoideæ. A natural order of shrubby or herbaceous perigynous Exogens, inhabiting hot sandy plains. They are related to *Crassulaceæ*, *Chenopodiaceæ*, and *Silenaceæ*, and especially to *Cactaceæ*; but are distinguished by their embryo being curved round mealy albumen, their superior calyx, and their perigynous stamens. The succulent leaves of some are eaten. The order is sometimes called *Mesembryaceæ*.

Fiction of Law. This term has been defined, by writers on the civil jurisprudence, to be an assumption of the law that a thing is true which is either not true or which is as probably false as true. The utility of such fictions was merely, by substituting the imaginary for the true state of the case, to pass more rapidly over those parts of the subject which were not disputed, and arrive at the points really in issue. The most notorious instances (the proceedings in ejectment, and for barring estates tail) are now, however, abolished.

Ficus (Lat.). The Fig is the fruit of *Ficus Carica*, a small tree with broad lobed leaves, inhabiting the south of Europe and Asia. This fruit is not of the same nature as the apple, the orange, and other fleshy seed-vessels, but is a hollow receptacle, containing a great multitude of minute flowers, the ripe fruit of which is the seed (as it is wrongly called) that is embedded in the pulp. It is remarkable that the fig-tree, though it produces so agreeable a fruit, is in some measure poisonous, its milky juice being acrid and of the same nature as that of certain Indian species called *F. toxicaria*, *dæmonum*, &c., from their venomous qualities. The genus itself is of considerable extent, and its species are among the most noble objects belonging to the vegetable kingdom in tropical countries, where they often yield caoutchouc of the finest quality. *F. elastica* is particularly valuable for this purpose. The Banyan-tree, *F. indica*, belongs to this genus. [Banyan.] The Pippul, or Sacred Fig of India, remarkable for its heart-shaped leaves with a long tail-like point, is *F. religiosa*.

Fid. A short bar of wood or iron put through the heel or lower part of a topmast, and resting by its ends on the trestle-trees, on which the mast is therefore supported. When the topmast is to be lowered, it is first lifted to take the pressure off the fid, which is then withdrawn.

Fid or **Splicing Fid.** A sharp cone of wood or iron for opening the strands of rope.

Fide Jussor. In the Civil Law, one who engages himself for the debt of another, promising to pay in case the original debtor should make default: he is called in the law of England a *guarantor*.

Fidei Commissum (Lat. *committed or intrusted to faith*). A species of testamentary disposition recognised by the Roman law, by which a testator, in indirect terms, charged his heir to deliver over to a specified person the whole or a part of the goods which he inherited. Fidei commissa were usually adopted as a means of bequeathing property to persons legally incapable of directly receiving the bequest. Fidei commissa were, as their name implies, at first dependent entirely on the faith of the heir for their execution; but their execution was rendered compulsory by Augustus in some cases; and this became afterwards the general law, the heir being, however, entitled, where he voluntarily accepted the testament and charged himself with its execution, to retain one-fourth of the property intrusted to him for delivery.

Fidei Defensor. [DEFENDER OF THE FAITH.]

Fief (Lat. feodum). The French name for an estate in lands held of a feudal superior. In English Law language, a *fee*: also termed a *feud* by writers on feudal jurisprudence. [FEUDAL SYSTEM.]

Field (Ger. feld; Dutch, veld). In Agriculture, a portion of land enclosed by a fence, or rendered distinct by some line of separation, so as to adapt it for culture. In former times, and until within the last two centuries, almost all the land cultivated with the plough throughout Europe was unenclosed; and the term *field* was then applied, in Britain at least, to the lands under culture by the plough. Subsequently, when farmers enclosed and subdivided a portion of the lands near the farmyard, these portions were called *fields*, the more distant portion which remained open being called *open field*, or *common field*; while grass lands unenclosed were called *commons*. In the present improved state of agriculture, every farm is divided into fields, either simply by lines of demarcation, which are sufficient when no animals are to be grazed on the farm; or by lines of separation which will act as fences, such as walls, hedges, ditches, &c., where cattle are to be grazed. Without some regular fixed division of arable lands, it would be next to impossible to conduct a rotation or succession of crops. It is interesting to observe that as agriculture in a rude state had no fences, so this is also beginning to be the case in agriculture in its most refined form; because it is found much more advantageous, for the production both of butcher's meat and manure, to consume the grass and herbage grown on farm lands in farmyards, with the single exception of that portion which is eaten by sheep; and these are confined to successive portions of grass land by light nets or hurdles, scarcely visible at a short distance. By thus getting rid of fences of every description, from a tenth to a twentieth will be added to the contents of the greater number of corn farms; and a very considerable first cost and annual expense will be saved in planting hedges or building walls, and in keeping them in repair afterwards.

FIELD. In Heraldry, the tincture, or combination of tinctures, which forms the ground of the escutcheon on which the device or charge is delineated. [TINCTURE.]

Field Lark. [LARK.]

Field, Magnetic. The space near the poles of a magnet through which the magnetic force is capable of exerting a perceptible influence.

Field Marshal. The highest military title in this and some other countries. The term is derived from the maréchal de camp in the old French service, and was long in use among the Germans in its present acceptation before it was adopted in this country.

Field Sketching. For Military purposes, the art of depicting in plan, quickly and faithfully, the natural features of a country, so as to give to an experienced observer the best possible idea of its character.

Field of View. In a telescope or microscope, the space within which objects are visible when the instrument is adjusted to focus.

Fieldfare. A bird of the Thrush tribe (*Turdus pilaris*, Linn.) which is a seasonal visitant in this island. It makes its appearance about the beginning of October, migrating from the colder northern parts of the Continent in flocks, numerous according to the severity of the season. They fly in a body; and if alarmed when dispersed over a field in quest of food, they collect together as they fly off, and often settle in a swarm on the same tree. They leave us about the latter end of February, or the beginning of March; and retire to breed in Sweden, Norway, Russia, and the northern parts of Asia as far as Kamtschatka.

Fieldvole. A name of the short-tailed field-mouse or meadow-mouse (*Arvicola agrestis*, Cuv.). Fieldvoles subsist exclusively on vegetable productions; and being, like the rest of the rat tribe, extremely prolific, multiply occasionally to such a degree, even in this country, as to become the most injurious of our wild quadrupeds. 'After having followed the labours of the reaper, and taken their share of the harvest, the fieldvoles (says Mr. Bell) attack the newly sown fields, burrowing beneath the surface, and robbing the husbandman of his next year's crop; and at length, retreating to the woods and plantations, commit such devastations on the young trees as would scarcely be

credible, were not the evidence too certain to be doubted. In the years 1813 and 1814 these ravagers were so great in the New Forest and the Forest of Dean, as to create considerable alarm lest the whole of the young trees in those extensive woods should be destroyed by them.' A timely attention to restraining their increase by the aid of terriers, ferrets, and traps, is imperative on those who have the charge of young plantations; but when the numbers of the fieldvole have surpassed the usual bounds, then it is recommended to dig holes about a foot in depth and the same in diameter, taking care to make them much wider at the bottom than at the top, so that the animal when once in cannot easily get out again. In holes of this kind Mr. Jesse states that at least thirty thousand fieldvoles were caught, in the course of three or four months, in Dean Forest plantations; that number having been counted out and paid for by the proper officers of the forest.

Fieri Facias (Lat. *cause it to be done*). In Law, a judicial writ, which lies where judgment is had for debt or damages recovered in the king's courts; by which writ the sheriff is commanded to levy the debt and damages on the goods and chattels of the defendant. Under it may be taken all personal goods and chattels, except wearing apparel to the value of five pounds; money and bank-notes; leases and terms for years. As to growing crops, see 14 & 15 Vict. c. 25.

Fife (Ger. pfeife). A small musical wind instrument of the flute species played by holes, shrill in tone, and rarely used except in military bands.

Fifteenth. In Music, an interval of two octaves; also a name given to a stop on the organ, a double octave above the diapason, as its name imports.

Fifth. In Music, one of the harmonical intervals or concords. It is the second in order of the concords, the ratio of the vibrations of the notes that afford it being as 2 : 3. It is called the *fifth*, because in the natural or diatonic scale of music it comes in the fifth place or order from the fundamental. The ancients called it *diapente*, and the Italians at present call it *quinta*. The *imperfect*, *defective*, or *false fifth*, called by the ancients *semi-diapente*, is less than the perfect fifth by a lesser semitone.

Fifth-monarchy Men. A fanatical sect, who formed a principal support of Cromwell during the Protectorate. They considered his assumption of power as an earnest of the foundation of the fifth monarchy, which should succeed to the Assyrian, the Persian, the Grecian, and the Roman, and in which Jesus Christ should reign with the saints on earth for the space of a thousand years. Upon the restoration of the royal family, and the return of the kingdom to its former principles in church and state, a party of these enthusiasts, headed by a man of the name of Venner, made a desperate insurrection in the streets of London, which was put down with the slaughter of a great number of them.

Fig. [Ficus.]

Figurate Counterpoint. In Music, that which contains a mixture of discords together with the concords.

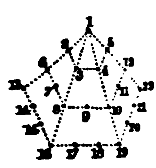
Figurate Numbers. In Arithmetic, a series of numbers derived from an ordinary arithmetical progression by a certain uniform law. They may be best defined by premising that an arithmetic series whose first term is 1 and common difference d, constitutes a series of *figurate numbers of the first order* and d^{th} class, and that the general or n^{th} term of a series of figurate numbers of the m^{th} order is the sum of the first n terms of the series of figurate numbers of the next lower or $(m-1)^{th}$ order. Thus for the figurate numbers of the first four orders and of the d^{th} class, we have—

$$\text{I}\quad 1, 1+d, 1+2d, 1+3d, \ldots\ldots 1+(n-1)d,$$
$$\text{II}\quad 1, 2+d, 3+3d, 4+6d, \ldots\ldots \frac{n}{1}\left(1+\frac{n-1}{2}d\right),$$
$$\text{III}\quad 1, 3+d, 6+4d, 10+10d, \ldots \frac{n(n+1)}{1.2}\left(1+\frac{n-1}{3}d\right),$$
$$\text{IV}\quad 1.4+d, 10+5d, 20+15d, \ldots \frac{n(n+1)(n+2)}{1.2.3}\left(1+\frac{n-1}{4}d\right)$$

The general law is evident; in fact, if we represent by the symbol $(m, d)_n$ the n^{th} figurate number of the m^{th} order and d^{th} *class*, or, what is the same thing, the sum of the first n figurate numbers of the $(m-1)^{th}$ order and d^{th} class, we have—

$$(m, d)_n = \frac{n\ (n+1)\ \ldots\ (n+m-2)}{1\ .\ 2\ \ldots\ (m-1)}\left(1+\frac{n-1}{m}d\right).$$

The figurate numbers of the second order and d^{th} class give rise to what are called *polygonal numbers* of the d^{th} order, which receive the special names of *triagonal*, *quadragonal*, &c. . . $(d+2)$-*gonal*, according as d has the values 1, 2, &c. . . . The origin of this nomenclature is traceable to the fact that a polygonal number of points may always be arranged so as to form and fill a regular polygon in a symmetrical manner. To illustrate this, take the pentagonal numbers 1, 5, 12, 22 . . . , corresponding to $m = 2$ and $d = 3$. Starting with the regular pentagon 1, 2, 3, 4, 5, and fixing upon any corner, produce its two sides 1, 2 and 1, 5, and its two diagonals 1, 3 and 1, 4, until their whole lengths are doubled; in this manner a second regular pentagon 1, 6, 8, 10, 12 will be obtained whose sides are respectively double those of the original. Midway between the points 6, 8, 10, 12, insert three $(5-2=d)$ new points 7, 9, 11, so that the points on the contour of the new pentagon may be at the same distance asunder as before. By elongating the sides and diagonals of the second pentagon to the same extent as before, and inserting two new points into each of the three sides opposite 1, a third pentagon of a similar nature will be obtained. Now the points forming the contours of the several pentagons will clearly correspond to an



arithmetical progression whose common difference is $d = 5 - 2 = 3$, and the points upon and within the several pentagons will correspond to the pentagonal numbers obtained by the successive summation of the terms of this arithmetic series.

In a similar manner the figurate numbers of the third order and d^{th} class lead to *pyramidal numbers* of the d^{th} order, which receive the distinctive names of *triagonal*, *quadragonal* . . . $(d+2)$-*gonal* as before. It is manifest, in fact, that a pentagonal pyramid could be formed by superposing, in a symmetrical manner, layers of pentagons of the kind just described; and according as such a pyramid consisted of 1, 2, 3, 4 . . . layers, it would enclose 1, 6, 18, 40 . . . points.

Figurate numbers of a higher order than the third of course transcend geometrical representation.

Figure (Lat. figura, *a shape*). In Geometry, a space bounded by lines or by planes. The term *figure*, when synonymous with *diagram*, denotes the representation (on paper for example) of the object of a theorem or problem.

All bodies are necessarily enclosed by one or more boundaries, and therefore possess figure: hence *figurability* is reckoned one of the essential properties of matter.

In Arithmetic, the numeral characters, or ten digits, by which numbers are expressed, are also termed *figures*. They are supposed to be of Indian origin, and to have been introduced into Europe by the Moors of Spain in the thirteenth century; but the date of their introduction is much disputed. [ARITHMETIC.]

FIGURE. In Logic, this word is applied to the form of a syllogism with regard to the disposition of the middle term. [TROPE.]

FIGURE. In Rhetoric, a mode of speech in which words are changed from their literal and primitive sense. It is almost impossible to give, within the limits of a definition, the meanings of which this term is susceptible; but under the separate heads, such as ANTITHESIS, METAPHOR, &c., will be found a notice of the different figures used in composition.

Figure of Merit. In rifle-shooting at a target, the number denoting the individual success of any rifle.

Figure-head. The figure, statue, or bust, representing the subject of the ship's name, on the projecting part of the prow, above the cutwater.

Filacer or **Filazer** (Fr. fil, *thread*). An officer of the court of Common Pleas, who files writs. The filacers (of whom there are fourteen) are mentioned as early as the stat. 10 Hen. IV. There are also filacers of the Queen's Bench.

Filaria (Lat. filum, *a thread*). A genus of *Entozoa*, which has been found under the skin of man in the cellular tissue, especially in the legs, sometimes attaining the length of ten feet, and causing great pain. It is commonly found in the hot countries of both the Old and New Worlds.

Filbert or **Filberd.** The well-known fruit of one of the varieties of the cultivated nut, *Corylus Avellana*. It is a seed-vessel enclosed within an involucre or cupule, which is commonly called the *husk*. This organ is of the same nature as the cup of the oak and the prickly case in which the nuts of the sweet chestnut and the mast of the beech are enclosed. In the filbert it is much larger than in the common nut; and this character, together with its lengthened figure, distinguishes the two races of nuts and filberts, each of which has many varieties. The best known varieties of the filbert are the red, the frizzled. and the white, the latter being most commonly grown in this country.

File (Ger. feile). An instrument for abrasion, consisting of a piece of steel, cut with a series of regular notches, so as to take hold of the surface, and remove the asperities. Files are known by the names of *round*, *half-round*, *triangular*, and *flat* files, which are applied to the various forms required to be produced; their temper and degree of fineness depends on the materials on which they are intended to act, and the degree of finish which they are required to produce.

FILE (Lat. filum, *a thread or line*). The Military term for two soldiers, front and rear rank men. Thus, a company of twenty-five files contains fifty men.

File Marching. The marching of a line two deep, when faced to the right or left, so that the front and rear rank march side by side.

Filefish (*Balistes*). A genus of Acanthopterygious fishes, in which the anterior dorsal spine is deeply serrated, and the skin excessively rough and shagreened.

Filibusters. This word is commonly used in America as a name for piratical adventurers of any nation. It is an Anglicised form of the French *flibustier*; but the latter is nothing more than a corruption of the English *freebooter*.

Filices (Lat. pl. of filix, *a fern*). One of the principal groups of *Acrogens*. They are commonly called Ferns, and consist of arborescent or herbaceous perennial, very rarely annual, plants. Those of arborescent habit have a trunk varying from two or three to sixty or eighty feet in height, formed of the consolidated bases of the fronds, surrounding a soft central mass of tissue. Those of herbaceous habit either have a caudex formed on a plan similar to the trunk of the arborescent kinds, but on a smaller scale, the young fronds forming the growing point; or they have a more or less fleshy rhizome whose growing point is in advance of the developement of the fronds, which are produced from its sides instead of its apex.

Ferns may be recognised by the circinate growth of their young leaves, and by their hypophyllous fructification. The fronds vary much in size and form; but, in the majority of instances, there is no material difference of aspect between those which are fertile and

those which are sterile. In some few, however, including the whole group of *Acrostichea*, there is a manifest contraction of the fertile fronds, which are sometimes reduced to mere ribs, clustering with spore-cases.

The spore-cases, which are collected into heaps called *sori*, consist of little one-celled vesicles, girt either longitudinally, vertically, or obliquely by a jointed ring, which nearly, or in some cases completely, surrounds them. This ring is elastic, and by its contraction disrupts the spore-case and scatters the contained dust-like spores. The sorus, or heap of spore-cases, is in some groups entirely naked, but in others is covered while young by a membrane called the *indusium*.

The spores are produced by cell-division within the spore-cases, and are consequently unattached, and variously shaped and sculptured. They consist of two coats containing a grumous mass. On germination the outer coat bursts, and the inner is elongated and protruded, and by cell-division becomes converted into a thin marchantiform frond or prothallus. On the under surface of the prothallus two kinds of bodies are borne, one of which, the antheridium, produces spiral ciliated spermatozoids; the other, forming the archegonium or female cell, being sunk in the tissue. The cell at the base of the archegonium, after impregnation, gives rise to a new plant, which is gradually developed, and is of different duration in different species, producing successive crops of spore-cases without further impregnation if the species is perennial.

Many schemes have been proposed for the classification of ferns, but that seems to be preferable which is based on the modifications of the vascular system taken in conjunction with the fructification. All ferns may be referred to one of the groups *Ophioglossaceæ*, *Marattiaceæ*, or *Polypodiaceæ*. The two former have the spore-cases ringless, and are distinguished by the first having the fructifications marginal on rachiform fronds, and the second having them dorsal on flat leafy fronds. The *Polypodiaceæ* are known by their spore-cases having a jointed ring. This group comprises much the larger portion of the order, and is divided into several minor groups. The *Ophioglossaceæ* are called *pseudo-ferns*, as they want the character of circinate venation present in all true ferns.

Filicic Acid. An acid obtained from fern root: it is a fatty matter, soluble in ether and in alkalies.

Filiform (Lat. filum, *a thread*). In Zoology, when a part is slender, thread-shaped, and of equal thickness.

Filigraine, Filigree or **Fillagree** (Ital. filigrano). A fine ornamental work of flowers, fruit, &c. formed with gold or silver wire. It is an Eastern invention, much cultivated in those provinces of Italy which have maintained an intercourse with the Levant.

Fill. The Sea term for bracing a yard which had been laid aback, so that the wind may act on the after or proper side of the sail.

Fillet (Fr. filet, *a thread*). In Architecture, a small square member placed above or below other larger members, in orders. The term is used by carpenters and joiners to express a small piece of wood to which boards, joists, or quarters are nailed.

Filose (Lat. filum). In Zoology, when a part ends in a thread-like process.

Filtration. The process by which liquids are separated from substances mechanically suspended in them; it is also sometimes used to separate colouring matters and other bodies which are in a state of solution, and which are removed by the substance or matter through which the liquids are filtered. Unsized paper is commonly used in the chemical laboratory for the former purpose, and is known under the name of *filtering paper*. In the arts, linen or woollen calico bags of different forms are frequently employed, containing charcoal or other materials, through which the liquids requiring purification are suffered to trickle slowly. In *water filters*, the coarser particles are generally collected in a piece of sponge, and the further separation of the more finely divided matters or organic taints is effected by layers of sand of various degrees of fineness mixed with a proper quantity of charcoal. (See Faraday's *Chemical Manipulation*; and Ure's *Dictionary of Arts, &c.*) The *filter-beds* of the London water companies are similar arrangements upon a proportionate scale.

Fimbriæ (Lat. *fringe*). In Anatomy, the jagged processes of the abdominal opening of the oviduct, or *Fallopian tube*, are so called.

Fin (A.-Sax. finna). A flattened expanded organ, projecting from the body, and serving as an instrument of locomotion in water.

Many species of the whale tribe possess an immovable fin upon the back, composed merely of a reflection of integument over a mass of dense and ligamentous cellular membrane; the tail fin in the same order has a similar structure, but is moved by the action of the muscles upon the caudal vertebræ, which are continued through the middle part. The anterior fins, corresponding to the pectorals in fish, are susceptible of greater variety of motion, from being supported by a series of bones corresponding to those of the fore extremity of other mammalia. In fishes the fins are supported by elongated filamentary bones or rays, the nature and number of which afford the zoologist important characters for distinguishing the different groups; and in works of Ichthyology a system of notation is employed, which briefly but clearly expresses these characters. Thus the formula of the number of fin-rays in the perch is thus expressed:—

$$d.\ 15, 1+13;\ p.\ 14;\ v.\ 1+5;\ a.\ 2+8;\ c.\ 17,$$

which signifies that *d.*, the dorsal fin, has in the first fin 15 rays, all spinous or bony; in the second fin, 1 spinous plus 13 that are soft. *p.*, pectoral fin, 14 rays, all soft. *v.*, the ventral fin, with 1 spinous ray plus 5 that are soft. *a.*, the aural fin, with 2 spinous rays plus 8 that

are soft. c., the tail or caudal fin, 17 rays. In enumerating the rays, those only which extend from the longest ray in the upper portion to the longest ray in the lower portion, both inclusive, are counted.

Final or Remaining Velocity of a Projectile. Its velocity at the end of any given range.

Finale (Ital.). In Music, the last of a series of movements in a composition; also the closing scene of each act of an opera.

Finance (Low Lat. financia). This word in English phraseology is generally limited to systems of taxation, and especially to the schemes by which governments attempt to secure the funds necessary for the administration of public affairs, and particularly by loans. Hence, as all taxation must be paid, as a rule, out of profits, and it is from profits only that capital is replaced and augmented, financial expedients are of great interest to economists, because an erroneous or mischievous system of finance may seriously impair the productive energies of a people, and induce that state in which the accumulation of capital ceases.

Up to comparatively late times, finance was never treated as a subject on which economical considerations are of paramount importance. Money was needed for public purposes, and financiers merely considered how it could be procured in the manner easiest to themselves, and not in the manner easiest to the nation. Hence laws were enacted which seriously affected the industrial powers of the community. For instance, during the greater part of the eighteenth century (according to Macpherson), the cost of collecting the customs revenue in Scotland exceeded the proceeds of taxes, and money had to be remitted from England in order to meet the charges incurred in procuring the revenue from the Scotch ports. Of course such a system was simple waste.

Of late years the principles of finance have been far better understood in this country, and taxation has been based upon a rational theory. But other communities are far in the rear of any sound doctrine on these subjects. Few countries, perhaps, were so ill-situated as England before the time in which the question was first agitated, and, with the exception of some details, practically settled. To this, probably, we may attribute the completeness of the reaction. But the financial schemes of the continental governments generally, and of the United States in particular, are a mass of irrational confusion and mischievous error. [TAXATION; NATIONAL DEBT.]

Finch. [FRINGILLIDÆ.]

Fine. In Law, as a punishment, is a pecuniary mulct or amende imposed by a competent jurisdiction. The party thus mulcted for offences against a feudal superior was said, in the language of that jurisprudence, 'finem facere de transgressione cum rege, domino,' &c., *to make an end* of his offence: whence the word *fine*. Fines are in no case determined as to amount by common law, and seldom by statute, except as to their maximum; but by the general cautions of Magna Charta and the Bill of Rights, excessive fines ought not to be imposed. Courts of record have in general the power of imposing fines in case of contempt, and also on conviction of offences punishable in this manner. The mode of returning, estreating (i.e. entering on the rolls of a court), and levying fines is now regulated by 3 & 4 Wm. IV. c. 99.

Fine of Lands. In Law, a species of fictitious conveyance or record for the settling and securing lands and tenements, now by stat. 3 & 4 Wm. IV. c. 74 rendered obsolete. [FEE TAIL.]

Fine Stuff. In Architecture, the preparation used in common ceilings and walls for the reception of paper or colour. It is composed of lime, slaked and sifted through a fine sieve, then mixed with a due proportion of hair and sand; the lime is a rich fat lime, and the sand is very fine. A coarser kind of material, used for the first or the rendering coat and for the floating coat, is called *coarse stuff*.

Fineering. [VENEER.]

Fingal's Cave. [BASALT.]

Finger-board. In Music, the black board attached to the neck of instruments of the viol class, on which the strings are pressed by the fingers for the purpose of adjusting their lengths so as to produce the different sounds.

Fingering. In Music, the art of arranging the fingers on instruments of all classes, so that they may be in the best positions for performing the different passages written for such instruments.

Finial (Lat. finis, *an end*). In Gothic Architecture, the top, or finishing, of a pinnacle, or gable, as it is now generally understood; but in ancient documents, an entire pinnacle is understood by this term. [CROCKETS.]

Finishing Coat. In Building, the last coat of stucco when three coats are used. When in the third coat fine stuff is used for affording a hold to the paper, it is called the *setting coat*.

Fiord. The Norwegian form of the word *frith* or *firth*, denoting those arms of the sea which penetrate deep into the land.

Fiorite. A silicious incrustation, from *Fiora* in Ischia.

Fir (A.-Sax. furh). A general name for various coniferous trees, but particularly applied to the species of *Abies*, some of which, occasionally separated under the name of *Picea*, are called Silver Firs. The name of Spruce Fir is given to the species of *Abies* proper, and particularly to *Abies excelsa*. The Firs are mostly valuable for their timber, which forms some of the varieties of Deal.

The word *fir* is identical with the Latin *quercus*. (Max Müller, *Lectures on Language*, second series, p. 222.)

Fir Timber. The wood obtained from any species of the genera *Pinus* and *Abies* is called by builders *fir*; though at the present day the tendency of the technical authorities is to limit the word to the wood proceeding from the ports

of Northern Europe: the American timber being known as *pine*; that from Vancouver's Island, as *masting timber*; and from New Zealand as the *cowrie wood*. There are different qualities in the fir brought to market, which are usually confounded by the London architects. The Baltic fir, which is obtained from the genus *Pinus*, is usually met with in scantlings of fourteen inches square; the Swedish, obtained from the same genus, is about ten or twelve inches square; and the Norway fir, eight inches to ten inches square, obtained from the *Abies*, is of very inferior quality.

Fire (Gr. πῦρ, Ger. feuer). [FLAME and HEAT.]

Fire of Artillery, or of other troops, is defined according to its direction as regards the line of works or troops fired at; *direct* when perpendicular to the front of the line, *oblique* when forming an angle with the front, *enfilade* when raking the length, *slant* when at a small, and *reverse* when at a large angle with the rear of the line. *Plunging* fire is that directed down from a height; *ricochet* is rebounding of the shot; *vertical* fire is throwing the shot high into the air, whence it falls among the enemy.

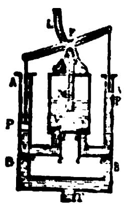
Fire Balls (called also *Bolides* and *Fiery Meteors*). In Meteorology, luminous bodies which suddenly appear in the sky, usually at a great height above the earth; they shoot through the heavens with immense velocity, and are sometimes accompanied with the fall of an aërolite. These meteors are of frequent occurrence; and are believed to be portions of matter composing several rings in the interplanetary spaces, through which the earth passes in its orbit. They pass with immense velocity through our atmosphere, and the consequent retardation of their motion developes so much heat as to dissipate them in most cases in vapour. Sometimes, however, from the greater size of the masses, or from their more vertical descent, they reach the earth in an intensely heated condition. [METEOR, LUMINOUS.]

Fire Blast. A term of very doubtful meaning, like the word *blight*. In Agriculture, it is sometimes applied to plants which are suffering from the mildew fungi or from minute insects; but it is properly applicable only when the delicate parts of plants are too suddenly exposed to a brilliant sun, and the rapid transpiration which takes place in consequence dries up and shrivels their leaves.

Fire Brick. A brick used for the purpose of lining fireplaces, furnaces, &c., which, from the nature of the clay of which it is made, is capable of withstanding a great degree of heat. The clay should be a nearly pure silicate of alumina, and free from lime. Stourbridge clay, which is in great request for the manufacture of fire bricks, contains from 60 to 70 per cent. of silica, and from 20 to 30 alumina, with traces only of oxide of iron and carbonate of lime. Some of the Monmouth and Newcastle clays are similarly constituted, and resist high temperatures without a tendency to fusion. [CLAY.]

Fire Damp. The explosive mixture of light carburetted hydrogen and air found in coal mines. [CARBURETTED HYDROGEN.] It is also generated in marshes, bogs, and stagnant pools.

Fire Engine. This most useful machine is constructed in a variety of forms, all of which, however, agree in one principle. It generally consists of a double forcing pump communicating with the same air-vessel; and instead of a force-pipe a flexible leathern hose is used, through which the water is driven by the pressure of the condensed air in the air-vessel. The annexed diagram represents a section of the apparatus in Newsham's engine. The pipe T descends into a receiver or vessel containing a supply of water. This pipe communicates with two suction valves V, which open into the pump barrels of two forcing pumps A, B, in which solid pistons P are placed.



The piston rods of these are connected with a working beam F, elongated so that a number of persons may work at both ends of it at once. Force pipes *t*, *t* proceed from the sides of the pump barrel above the valves V, and they communicate with an air-vessel M, by means of forcing valves V, which also open upwards. The pipe descends into the air-vessel near the bottom. This pipe is connected with the flexible leathern hose L, the length of which is adapted to the purposes to which the machine is to be applied. The extremity of the hose may be carried in any direction, and may be introduced through the doors and windows of buildings. By the alternate action of the pistons, water is drawn through the suction valve, and propelled through the forcing valves, until the air in the top of the vessel M is highly compressed. The pressure acts on the surface of the water in the vessel, and forces it through the leathern hose in a continued stream, so as to spout from its extremity with a force depending partly on the degree of condensation, and partly on the elevation of the end of the hose above the level of the engine. It is to be considered that the pressure of the condensed air has, in the first instance, to support a column of water, the height of which is equal to the level of the end of the tube above the level of the water in the air-vessel; and until the pressure exceeds what is necessary for this purpose, no water can spout from the end of the hose; and, consequently, the force with which it will so spout will be proportional to the excess of the pressure of the condensed air above the weight of the column of water, whose height is equal to the elevation of the end of the hose above the level of the water in the air-vessel. (*Cabinet Cyclopædia*, 'Hydrostatics and Pneumatics,' p. 326.)

The fire engine has received various improvements from Bramah, Dickenson, Simpkin, Raventree, Philips, and others. The first steam fire engines made in London were by

Mr. Braithwaite in 1830. One or two were worked publicly at fires, and were afterwards sold to continental governments. Some years afterwards they began to be generally used in North America, and in 1855 their use in London was revived when the London fire brigade had a powerful floating steam fire engine constructed for use on the river Thames. This engine was designed and constructed by Messrs. Shand, Mason and Co., who in 1858 made the first land steam fire engine which had been constructed since those of Braithwaite. This engine was sent to St. Petersburg for the Russian government; a second engine was made and used experimentally by the London fire brigade during the year 1860, the result of which was very successful. At the Exhibition of 1862 there was a competition of steam fire engines: see Jurors' Report, International Exhibition, 1862, Appendix to Class 8, Special Jury for Fire Engines, where full particulars are given of the details of the engine.

Fire Escape. Any machine or apparatus for the purpose of enabling persons to escape from the upper storeys of houses on fire. The many contrivances which have been proposed for accomplishing this desirable object are of two kinds; the first kind comprising those by means of which the escape is effected without external aid, and the second those requiring the assistance of persons without. Of the first kind the most obvious is a rope ladder, which may be kept in a sleeping apartment, and used, when needed, by fastening one end of it to a window-sill or bedpost. But unfortunately contrivances of this kind can rarely be of any use; for supposing them at hand when the alarm of danger is given, few persons can command the coolness and attention which are requisite for fixing and adjusting the apparatus; and even then it is only the strong and active who could safely descend by such means from a considerable height.

In escapes of the second kind, the object is to enable persons without to establish speedily a communication with an upper room, so as to afford the inmates the means of safe descent; or to remove them if necessary, as in the case of the feeble or children. Mr. Braby's fire escape, described in the thirty-fourth volume of the *Transactions of the Society of Arts*, consists of a car or cradle, which is made to slide on a slip of plank fixed to a pole, and is governod by a rope. Mr. Ford's escape consists of a spar of timber about thirty-five or forty feet long, having two projecting arms at the top furnished with prongs, by which a firm bearing against the wall of a house is obtained. A grooved pulley is mortised into the spar near the top, and another near the bottom; over the pulleys runs an endless rope, to which is attached at one point a main rope, and at another the semicircular brace of a large grooved roller, which traverses up and down the space between the pulleys. This brace carries on the under side of the spar a hook, to which a cradle is attached by which persons can be easily lowered to the ground.

In the year 1819, Mr. J. Gregory patented a fire-escape ladder consisting of sliding ladders placed upon a movable carriage, and capable of being extended by the successive drawing out of the separate parts. This apparatus is described and illustrated in the *Mechanic's Magazine*, No. 295. In the year 1840, Messrs. Harvey and Braidwood recommended for use in the city of London a fire escape which was founded upon Gregory's invention, and which contained some valuable additions and improvements designed by Mr. Wivell. Mr. Wivell's fire escape is described in the *Mechanic's Magazine*, No. 723. The principal feature in the modern apparatus consists in the addition of a long canvas trough, extending the whole length of the main ladder, and intended not only to facilitate the descent of weak and timid people, but also to protect them from the heat of any issuing flames; and so necessary is some safeguard of this kind, that it is essential to protect the canvas trough itself by a metal screen.

The escape now in use consists of a main ladder about twenty-four feet long, provided with a canvas trough, and capable of extension to a greater length, either by sliding out additional pieces, or by folding back a light ladder which is hinged upon a joint at one extremity of the main portion. It is balanced upon the axis of a pair of wheels, so that two men can move it promptly and readily from place to place, and it appears to be the most simple and effective of all the numerous contrivances which have hitherto been suggested.

For a description of various other contrivances of a similar kind, see the *Transactions of the Society of Arts* above quoted, and the *Mechanic's Magazine* for January and July 1863, and July 22, 1864.

Fire Fly. A name commonly given to those insects which have the singular property of emitting a luminous secretion. This power is not confined to insects of one organisation or order. Among the Coleoptera, the *Elater noctilucus* and the female glow-worm are conspicuous examples. The *Fulgoridæ*, or lantern and candle flies, are also described, but some think apocryphally, as luminous insects.

Fire, Greek. An incendiary composition which was discharged from tubes; a fact which has led many engineers to confound it with gunpowder, and these tubes with cannon. It was known in the east of Europe as early as the year A.D. 673, when, it is said, Callinicus, an architect of Heliopolis, taught the use of it to the Greeks. It did not reach the west of Europe till much later. A receipt for its composition may be found in the Treatise of Marcus Græcus, and in a Spanish MS. of the thirteenth century, in the Bodleian Library.

Fire Lock. A term applied in the sixteenth century to the musket or pistol with a wheel lock, and later to that with a flint lock.

Fire Raising. [ARSON.]

Fire, St. Anthony's. [ERYSIPELAS.]

Fire Worshippers. [GUEBRES.]

Fireship. A vessel filled with combustible materials for the purpose of being sent in a burning state among the ships of an enemy, in order to set them on fire. As the destruction of the vessel itself is a necessary consequence, it must be abandoned by the men, and therefore cannot be steered after ignition has been effected. Hence fireships are formidable only to vessels which cannot be manœuvred, either by reason of their having been disabled, or on account of their occupying a confined space, as a harbour, where there is not room for escape.

Fireworks. [PYROTECHNY.]

Firkin. A measure of capacity, being the fourth part of a barrel, or containing 9 ale gallons or 7½ imperial gallons; that is, 2,538 cubic inches. The word is a diminutive of *four*, with which the terms *farthing* and *firlot* may be compared.

Firlot. Strictly, the *fourth* part of a boll of meal. A dry measure used in Scotland, but of different capacities according to the article it is used for measuring. The Linlithgow *wheat firlot* is to the imperial bushel as ·998 to 1; and the *barley firlot* to the imperial bushel as 1·456 to 1.

Firmament (Lat. firmamentum, *a support* or *prop*). In the language of the old astronomers, the orb of the fixed stars, or the most remote of all the celestial spheres. In common language it signifies the same thing as *heaven* or *sky*. [HEAVEN.]

Firman (more properly *Fermân*). In the Persian language, this word signifies a command, and is applied in Turkey, Persia, and India to mandates or certificates of the sovereign, issued for various purposes. Those best known to Europeans are given to travellers, and serve as passports. The fermân has at its head in Turkey the cipher of the reigning sultan, written in a complicated manner, affixed by the chief secretary of the sign manual.

First Coat. In Architecture, the *laying* the plaster on the laths, or the *rendering*, as it is called, on brick when only two coats are used. When three coats are used, it is called *pricking up* when upon laths, and *roughing in* when upon brick.

First Fruits (Annates or Primitiæ). The profits of every spiritual living for the first year after its avoidance, which the new incumbent paid in Catholic times to the pope, but since the Reformation to the king. The valuation is that which was made by Henry VIII. The statute 2 Anne transfers the first fruits and tenths of all livings over 50*l.* at that time to a fund called Queen Anne's Bounty, for the increase of the smaller benefices, those under 50*l.* being released from any payment of the kind.

Firth. [FRITH.]

Fiscal (Lat. fiscalis, from fiscus, *a purse*). Anything relating to the pecuniary interest of the sovereign or the community.

Fischerite. One of the native hydrated phosphates of alumina, named after its discoverer, Fischer.

Fiscus (Lat.). [ÆRARIUM.]

Fish. In Architecture and Engineering, a piece of wood, or metal, secured to the side of another piece in order to strengthen it.

FISH. In Nautical phraseology, has two significations: first, it is an apparatus of blocks and ropes used in hauling up the flukes of an anchor towards the ship's bows, to prevent them from catching in passing objects; secondly, *fish-fronts* are curved pieces of timber bound along the outside of a broken spar, to give it firmness. *Side-fishes* are the convex timbers forming the rounded sides of a made mast.

FISH. In Zoology. [PISCES.]

Fish Davit. In Navigation, a piece of wood or iron for lifting the fluke of the anchor to the bill board.

Fishery. The fisheries of the British Islands are partly coast and river, and partly carried on in the open sea at a greater or less distance from the shore. Of the former, salmon, herring, pilchard, and oyster are most important; of the latter, cod, turbot, and whale. 1. The salmon fishery has considerably diminished in importance of late years. That of Scotland is regulated by 9 Geo. IV. c. 39 and subsequent Acts. 2. The herring fishery, at first almost engrossed by the Dutch, was fostered in 1749 by a tonnage bounty granted on vessels employed in it. Under this system the fishery does not appear to have thriven. The bounty was gradually withdrawn, and finally ceased in 1830. The most important seats of the herring fishery at the present day are the coasts of the north-east of Scotland. In 1834, 11,000 boats and 82,000 persons (fishermen and boys, coopers, curers, &c.) were employed in this fishery. 3. The pilchard fishery is carried on almost entirely on the coasts of Devon and Cornwall. 4. Oysters are found on most parts of our coast, but the principal seats of the trade of breeding them for the London market are Kent and Essex. 5. Turbot, cod, and mackerel are the principal articles of the fisheries off the British coasts. Turbot are chiefly caught by Dutch fishermen, close to the shores of Holland. In 1833 a report was made by a committee on the British Channel Fisheries, in which the declining state of those fisheries is much commented upon, and attributed to three causes: the extensive interference and aggression of the French fishermen on the coasts of Kent and Sussex; the large quantities of foreign-caught fish illegally imported and sold; and the great decrease and comparative scarcity of fish in the Channel; which last they attribute to the destruction of spawn. But by far the greatest fishery of cod, hake, ling, &c. is carried on on the great bank of Newfoundland, and on the neighbouring coasts. The former is now chiefly engrossed by the French and Americans; but the British fishery, although principally confined to the coasts of Newfoundland and Labrador, is very extensive. The following table shows the importance of the cod fishery to Newfoundland:—

	Quantities of Codfish exported	Value in Pounds Sterling
1855	1,107,388 cwt. . .	680,283
1856	1,268,334 quintals .	789,124
1857	1,392,322 „ . .	1,006,129
1858	1,038,089 „ . .	765,101
1859	1,105,793 „ . .	894,966

(Hind's *Explorations in Labrador*, chap. xxxv.) 6. The Greenland whale fishery was engaged in by the English in the seventeenth century, but not with vigour until encouraged by a bounty in 1740. Since the close of the wars with the first Napoleon, it has declined in importance. In 1815, 146 vessels sailed; in 1834, 76 only. The southern whale fishery is a more modern branch of the traffic. (M'Culloch, *Statistics of Great Britain*, ii. 21 &c.; article 'Fisheries' in *Encyclopædia Britannica*; Report of the Committee on the Channel Fisheries, 1833: the former writer estimates the annual value of the fisheries at about 3,000,000*l*. per annum.) The coast and sea fisheries are protected by a variety of enactments. (See 18 & 19 Vict. cc. 3, 101, 19 Vict. c. 17.) Fishing vessels are licensed by the commissioners of customs under 6 Geo. IV. c. 108. As to inland fishing, the law of offences in private fisheries is now consolidated by 7 & 8 Geo. IV. c. 27. Taking or destroying fish in water running through or in land adjoining or belonging to the dwelling-house of the owner of the water, is a misdemeanour; in any water not within this description, but private property, or in which there is a private right of fishing, it is punishable with fine on summary conviction. Angling in the daytime is not within these enactments, but is punishable summarily with less penalty. The right of fishing in a river primâ facie belongs to the lord of the manor, who has the ownership of both banks. Fishery is said to be either *several* or *free*, or *common of piscary*. The first is in the owner of the soil, or one deriving title from him; the second is a royal franchise, conveying an exclusive right of fishing in a public river. Common of piscary is a liberty of fishery in common with others in a stream or river the soil whereof belongs to a third person, and resembles other commonable rights.

Fishponds. Ponds in which different kinds of fish are bred and fattened. In general this is only attempted with fresh-water fish; but in some places ponds have been formed on the seashore, and so contrived as to have their waters renewed every tide, and in these sea fish have been kept for use for a considerable time. The fresh-water fish most successfully managed in ponds are carp and tench.

Fissipara (Lat. findo, *I divide*, and pario, *I bring forth*). Those animals are so called which propagate by spontaneous fission, or the detachment of a greater or less proportion of the body, having inherent power of self-support and growth. As the animals which manifest this mode of generation differ widely among themselves in their general organisation, the term *Fissipara* cannot be applied to designate any natural group; spontaneous fission is limited to the lowest classes of animals, as *Infusories*, *Polyps*; certain worms, as the *Naïs*, &c.

Fissiped (Lat. fissipes, *cloven-footed*). In Zoology, a term applied to animals whose toes are not connected by a membrane.

Fissirostrals, Fissirostres (Lat. findo, and rostrum, *a beak*). The name of a tribe of perching birds (*Insessores*), comprehending those which have a very wide gape, as the swallow.

Fissurella (Lat. findo). A genus of Gastropodous Molluscs, having a shell shaped like that of a limpet (*Patella*), but with a fissure at the apex of the cone, which opening is associated with a different form and arrangement of the breathing organs.

Fistula (Lat. *a pipe*). A long sinuous ulcer, often communicating with a larger cavity, and having a small external opening.

Fistulidans, Fistulides (Lat. fistula, *a pipe*). A tribe of Echinodermatous animals, comprehending those which have an elongated cylindrical tube-like body.

Fitch. [Vetch.]

Fitchet. In Zoology, the polecat, or *Putorius fœtidus*.

Five Points. [Arminians.]

Fixed Air. The old term for *carbonic acid*, from its existence in a fixed state in limestone, &c.

Fixed Oils. The common greasy oils are so termed in consequence of the high temperature which they sustain before giving out vapour.

Fixed Stars. Stars which retain the same or very nearly the same position with respect to each other. It has been discovered, by the accurate observations of modern times, that many of the stars have a proper motion. [Stars.]

Fixture. In Law, a term generally applied to all articles of a personal nature affixed to land. This annexation must be by the article being let into or united with the land, or with some substance previously connected therewith. Thus a barn, built on a frame not let into the earth, is not a fixture; a brewer's stills, set in brickwork resting on a foundation, are fixtures; and the application of the same principle gives, in every case, the true rule to judge whether anything be a fixture or not. Whatever is thus fixed becomes, by law, parcel of the freehold or realty. It is, therefore, on general principles, not removable; but there are exceptions to this rule established by custom; of which the principal arise out the right of tenants to remove fixtures set up for purposes of trade, and in some instances for ornament and convenience (commonly called *tenant's* fixtures), and the right of executors to some fixtures, generally of the same description, as against the heir or devisee of the realty. By the Act 14 & 15 Vict. c. 25 s. 3 useful erections by the tenant of a farm, put up with the consent of the landlord, were placed on the footing of tenant's fixtures.

Flabelliform (Lat. flabellum, *a fan*). In Botany, fan-shaped—as the plaited leaves of some palms.

Flacourtiaceæ (Flacourtia, one of the genera). A natural order of hypogynous Exogens, of the Violal alliance, sometimes known under the name of BIXACEÆ [which see]. In this group they are known by their leaves being either dotless or marked with round (not linear) dots, by their flowers being scattered, and either apetalous or polypetalous, and by their petals and stamens being both hypogynous. They are tropical trees or shrubs, and furnish in the case of some species of *Flacourtia* subacid edible fruit, and in that of *Bixa* the arnotto used for colouring cheese.

Flag. On board Ship, the flag is employed to designate a vessel's nation and employment, and also as a means of communicating intelligence. The national flags are *standards*, ensigns, and pendants (pronounced *pennants*). British vessels bear in addition as a distinguishing mark the union jack. Flags of occupation are the particular emblems borne by admiralty and war department vessels, yachts of the several clubs, ships belonging to companies, pilot-boats, &c. Flags of intelligence are of three shapes, square, triangular, and burgees: they are of one or two colours, and each represents a number or letter. By combinations messages may be transmitted with great rapidity as far as a telescope can cover.

Flag-lieutenant. The immediate attendant upon an admiral. He communicates his orders to the several ships in the command, and performs duties which resemble, mutatis mutandis, the functions of an aide-de-camp in regard to a general officer.

Flag-officer. In the Royal Navy, an officer entitled to bear at the masthead of his ship his personal distinguishing flag. This privilege is limited to admirals, vice-admirals, rear-admirals, and commodores.

Flag-ship. In a fleet, that vessel which bears the admiral's flag, and to which all other ships look for orders.

Flagella (Lat. *vine shoots*: Virg. *Georg.* ii. 299). A term used by the older botanists to denote the twigs or youngest shoots of plants.

Flagellants (Lat. flagellum, *a whip*). A sect of enthusiasts who first appeared in the middle of the thirteenth century, and being then repressed, sprang up again with renewed violence in the fourteenth. Beginning first at Cremona in Italy, the contagion of the example spread in a few years throughout Europe; and every city was infested by multitudes who went naked from the loins upward, and inflicted upon themselves several daily flagellations, with the idea of obtaining thereby merit in the eyes of God. They formed themselves into a society, and at first were innocent in their behaviour; but as their numbers increased, they gave way to great excesses, and were eventually suppressed by a holy war proclaimed against them by Pope Clement VI.

Flagelliform (Lat. flagellum). In Botany whip-shaped. A term applied to a long, pliant, whip-like stem.

Flagelliform Filaments. Appendages, on many Infusoria, proceeding from the anterior part of the body, and of which the terminations alone exhibit a vibratory movement.

Flagellum (Lat.). In Botany, a trailing shoot, such as that of the vine; the word is also sometimes used to denominate that form of stem called a *runner*.

Flageolet (Fr.). A wooden musical wind instrument, played with a mouthpiece, the holes and keys whereof are stopped with the fingers, in the same way as the flute.

Flagstones. Sandstones, calcareous sandstones, or argillaceous limestones of considerable hardness and toughness, very flatly bedded and more or less fissile, splitting into large thick slabs useful for paving, are called *flagstones*. Some of the best are the Yorkshire flags and those from Caithness; the former from the millstone grit and coal measures, the latter from the old red sandstone. England is very rich in rocks of this kind.

Flail (Ger. flegel, Fr. fleau, Lat. flagellum). A wooden implement for threshing corn by hand. It consists of the handle or handstaff, which the labourer holds in his hand, and uses as a lever to raise up and bring down the swiple, or part which strikes the corn and beats out the grain and chaff from the straw. The swiple is joined to the handstaff by the caplins or couplings, which are thongs of untanned leather, and sometimes the skins of eels or of other fish. These thongs are passed through holes in the ends of the handle and swiple, and made fast by being sewn together. The flail was in use among the Romans, though the prevailing mode of separating corn from straw among the nations of antiquity was by treading it out with cattle in the open air. In the colder parts of Europe, this could never have been generally the case for obvious reasons; and hence the flail was the universal threshing implement till the introduction of the threshing machine, which has now taken the place of the flail everywhere in this country. [THRESHING MACHINE.]

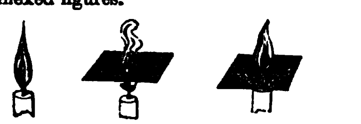
Flake White. A term often applied to the purest *white lead*.

Flame (Ger. flamme, Lat. flamma). When the temperature of inflammable gases or vapours is raised very high, and in the contact of air, they are said to *burst into flame*; if previously mixed with a due proportion of oxygen, or of atmospheric air, they *explode*. In the former case the combustion goes on only at the surface in contact with air, and is quiet and gradual; in the latter, every particle of the inflammable body being in contact with the supporter of combustion, the inflammation extends instantaneously through the whole mass. The nature of flame was first explained by Hooke in 1677 (in his *Lampas*); but the relation of the light to the heat of flames, and the whole philosophy of their constitution, was first developed by Sir H. Davy in his researches published in the *Philosophical Transactions* between 1815 and 1817.

All the leading phenomena of flame are well exhibited by a large gas-flame burning from a wide orifice. It presents a hollow cone, the heat and light of which are confined to its exterior surface. A transverse section of such a flame exhibits a ring of light surrounding a central uninflamed core: the inflammable gas or vapour may be drawn by a tube out of this central portion, as in the annexed figure, where *a* represents the tube inserted into the central non-luminous part of the flame, and where the abstracted inflammable vapour is again kindled at its extremity.

A flame may be extremely hot without being proportionately luminous, as is the case with the flame of hydrogen, which is scarcely visible in daylight, but the heat of which is shown by introducing into it a piece of fine platinum wire, which immediately becomes white hot, and emits abundance of light. The *light* of all flames is of a similar origin, and depends upon *solid matter* ignited and rendered incandescent by the heat of the flame: thus if magnesia or lime in fine powder be projected into the flame of hydrogen, the luminosity of the flame is immediately increased. Finely divided charcoal is the substance to which all common flames owe their luminosity. It is derived from the hydrocarbon produced by the decomposition of oil, wax, tallow, &c., as contained in coal gas; but as charcoal, unlike magnesia and lime, is itself combustible, it not only renders the flame luminous, but is burnt in the act of so doing, and passes off, in a well-regulated and perfect flame, in the invisible form of carbonic acid gas.

When flames are cooled, they are at the same time extinguished; hence a flame cannot be made to traverse or recede through a metallic tube of small bore; and a flame may, as it were, be bisected by a piece of wire gauze held transversely across it: in which case the smoke, gas, or vapour and charcoal go through, but not hot enough to inflame, having been cooled down by their passage through the metallic meshes; but by applying a flame to this smoke, it may again be kindled. In this way the upper portion of the flame may be burnt, while the inflammation of the lower half is prevented by the interposed cooling medium. These experiments are best illustrated by the flame of a gas-burner, and the two cases just cited are represented in the annexed figures.



Flamen. The title applied by the Romans to the priests of any particular deity as distinguished from priests in general, the most important being those of Jupiter, Mars, and Quirinus (Romulus). [AUGUSTALES.]

Flamingo. [PHOENICOPTERUS.]

Flange (perhaps connected with *flank*). The name given to the plate projecting from the side of a girder, or piece of iron, by which it can be connected with another.

Flank. In Fortification, that part of the bastion which reaches from the face to the curtain. The flank of one bastion serves to defend the ditch before the curtain and face of the opposite bastion. [FORTIFICATION.]

Flank of an Army. The right or left side, as distinct from the front or rear.

Flannel. [WOOL.]

Flashings (perhaps connected with Fr. flaque, *a splash*). In Architecture, pieces of lead, or other metal, let into the joints of a wall so as to lap over the gutters, or other conduit pieces, and prevent the splashing of rain from injuring the internal work.

Flat (Ger. platt). In Architecture, that part of a roof laid horizontally, and covered with lead or some other metal.

FLAT. In Music, a character of the form ♭, which depresses the note before which it is placed a chromatic semitone. Thus D ♭ signifies a semitone below D natural (♮). On keyed instruments the short keys are the representatives of these flats and sharps.

Flat Fifth. In Music, an interval of a fifth depressed by a flat, called by the ancients *semidiapente.*

Flat Fish. [PLEURONECTES.]

Flatten a Sail. To extend it fore and aft, whereby its effect is lateral only.

Flatting. In Architecture, a coat of paint, which from its mixture with turpentine is enabled to be worked *flat*, or to be finished with a perfectly even unvarnished tone.

Flatulency (Lat. flatus, *blast*). A morbid collection of gas in the stomach and bowels, commonly symptomatic of constipation and indigestion, or of indulgence in certain kinds of vegetable food. Warm tonics, aperients, and well-seasoned animal food, with weak brandy-and-water as a beverage at dinner, are the usual and effective remedies.

Flax (Ger. flachs). The fibre of the *Linum usitatissimum*, which is spun into thread and woven into *linen* textures.

The flax is pulled a little before the seeds are ripe; it is stripped, and the stalks are then soaked in water, when fermentation running into putrefaction ensues, so as to destroy the foreign matters with which the fibres are blended in the plant. The flax is then dried, and broken or beaten and winnowed, so as to separate the fibrous from the other parts; these are afterwards heckled, and prepared for the spinner. (For an account of these operations, and of the machinery by which they are effected, see Ure's *Dictionary of Arts &c.* art. 'Flax.')

Flea. In Entomology. [PULEX.]

Fleam (Dutch, vlieme; Fr. flamme, *a lancet*). An instrument used by farriers to bleed horses and cattle.

Flèche (Fr.). In Fortification, a simple redan usually constructed at the foot of a glacis. [REDAN.]

Fleece, Order of the Golden (Fr. toison d'or). One of the most distinguished among

European orders of knighthood. It was founded by Philip III., duke of Burgundy, in 1430; and as by its foundation his successors were declared to be hereditary grand masters, that title passed, with the Burgundian inheritance, to the house of Austria; thence, after the death of Charles V., to the Spanish line of that house: but when the monarchy of Spain passed to the Bourbons, and the Spanish Netherlands to Austria, the archdukes of Austria claimed the grand mastership; and claims are made on it at present both by the emperor of Austria and king of Spain. The order is consequently conferred both at Vienna and Madrid, and is, in both courts, the highest in point of rank. As its nominal object is the protection of religion, it is rarely conferred on any Protestants, with the exception, by courtesy, of Protestant sovereigns.

Fleet (A.-Sax. flota, *a ship*, Fr. flotte). In its most extended signification, this term is applied to a number of ships, pursuing in company either mercantile or warlike purposes, or both; but it is more generally confined to the different detachments which form the *navy* of any country, stationed in various parts of the world for the purposes of defence, aggression, or intimidation. [NAVY; SQUADRON.]

Flemish School. In Painting, the school formed in Flanders; established originally by the brothers Van Eyck at Ghent and Bruges at the commencement of the fifteenth century. It seems to have been allied to the old school of Cologne in its method of execution, but the Van Eycks exchanged the *tempera* vehicle for varnish. Memling, Roger Vander Weyden, Quintin Matsys, Mabuse and Antonij Moro were the great masters of the earlier period. Rubens and Vandyck were the great masters of the second period, after it became the fashion to study in Italy. Snyders, Jordaens, Gaspar de Crayer, and the younger Teniers were also great masters. The works of this school are distinguished by the most perfect display of chiaroscuro; high finishing without dryness; by an admirable union of colours well blended and contrasted, and by a flowing luxurious pencil. But the Flemish painters, like the Dutch, represented Nature as they found her, and not as she should be. Rubens and Vandyck, though men of the greatest genius, were not free from this defect. (*National Gallery Catalogue*, 1865; Michiels, *Rubens et l'École d'Anvers*, Paris 1854; and the *Catalogue du Musée d'Anvers*, 1857.)

Fleta. The title of an ancient treatise on English law, attributed to the reign of Edw. I. and named (according to tradition) from its composition by a judge in the Fleet prison.

Fleur-de-Lis (Fr.). In Heraldry, a charge supposed to represent a lily: borne from a very early period in the royal arms of France. It is, however, more probable that the shape of this bearing was intended to represent the iron of a javelin.

Flexibility (Lat. flexibilis, *pliant*). That property of bodies in virtue of which, when a sufficient force is applied to them, they change their form, and are bent. Flexibility is opposed to *stiffness* on the one hand and to *brittleness* on the other; stiff bodies being such as resist bending, and brittle those which cannot be bent without a disruption of their parts. [STRENGTH OF MATERIALS.]

Flexor Muscles. In Anatomy, muscles the office of which is to *bend* the joints.

Flexuose (Lat. flexuosus, *full of turnings*). In Botany, applied to bodies which have a zigzag or wavy direction, i.e. gently bending alternately in opposite directions, as in the case of some stems, the ribs of leaves, &c.

Flexura (Lat. *a bending*). In Mammalogy, the joint between the antibrachium and carpus, usually called the *fore-knee* in the horse; analogous to the *wrist-joint* in man.

Flexure. In Geometry, the bending or incurvation of a line or surface. A POINT OF CONTRARY FLEXURE is synonymous with a POINT OF INFLEXION; it is the point of contact of a STATIONARY TANGENT [see these terms].

Flint (Ger. flins). A variety of Quartz somewhat allied to Chalcedony, but more opaque and of dull shades of grey, yellow and black. Common flints are nearly pure silica. They occur in layers of irregular nodules and sometimes in flat tabular bands in the Chalk formation of England and the north of Ireland, in courses which are mostly parallel with the stratification. They often include organic remains, especially of infusoria, echini, shells and sponges. When two pieces of flint are rubbed together, they phosphoresce, and exhale a peculiar odour. After being calcined and ground, Flints are often used in the manufacture of earthenware and porcelain. They are also employed in Chalk districts as a building material and for making roads. [FLINT IMPLEMENTS.]

Flint Glass or **Crystal.** A species of glass which derives its name from flint, because that substance was formerly employed in its manufacture. It is extensively used for domestic purposes. Its dispersive power in regard to light renders it invaluable in the manufacture of the object-glasses of telescopes and microscopes; for by combining a concave lens of flint glass with one or two convex lenses of *crown glass* (which possesses a much less dispersive power), a compound lens is formed, in which the prismatic colours arising from a simple refraction are destroyed, and the lens rendered achromatic. This construction of object-glasses was first discovered by Mr. Hall, a country gentleman in Worcestershire, about 1729; but the discovery was forgotten, and no further notice taken of it for nearly thirty years, when it was again brought to light by John Dollond, after a long-continued course of experiments undertaken for the purpose of perfecting the telescope. It is, however, very difficult to prepare flint glass fit for achromatic telescopes, owing to its imperfect homogeneity; the slightest inequality in this respect giving rise to a confused and imperfect image. The

composition of glass free from such faults long remained a secret in the family of the Dollonds, and its manufacture formed a profitable article of exportation; for till about the beginning of the present century, no flint glass of good quality was made on the Continent. Of late years, however, glass of the best quality has been manufactured, both in France and Germany, in much larger masses than our English artists had succeeded in obtaining before Chance's time. This was mainly brought about by the experimental researches of D'Artigues, Fraunhofer, Cauchoix, Guinand, and Korner. Formerly, an object-glass exceeding five inches in diameter could scarcely be produced. Fraunhofer succeeded in making them of nine, and even twelve inches. There is a valuable paper on the manufacture of glass for optical purposes, containing the results of an extensive series of experiments upon the subject, made in the laboratory of the Royal Institution, by Mr. Faraday, in the *Philosophical Transactions*, vol. cxx.

Flint glass for common purposes is usually made of 120 parts of fine white sand, 40 parts of well-purified pearlash, 35 parts litharge or minium, 13 parts nitre, and a small quantity of the black oxide of manganese; the latter ingredient being used to correct the green colour occasioned by the presence of traces of oxide of iron. The principal difference between flint and crown glass consists in the large proportion of oxide of lead in the former. [OBJECT-GLASS.]

Flint Implements. From time to time, for at least three-quarters of a century, there have been suggestions and supposed discoveries of certain indications of human remains in rocks of a date anterior to the most ancient human records. Such indications, consisting chiefly of stony materials imperfectly sculptured, have attracted great attention for some years past, and their position has lately been clearly and satisfactorily determined. They have been found in and actually form part of gravels containing many bones of extinct gigantic animals, the inhabitants of the earth in times long past, mixed, occasionally though rarely, with bones of men. As most of these sculptured stones hitherto found in France and England consist of flints, they may properly be considered under the head of *flint implements.*

The precise nature of these implements, the fact that they must have been of human manufacture, and the clear proof of their position in situ with bones and other remains of animals contemporaneous with the savages who made the implements, are the points of chief interest.

They are principally composed of flint, but include granite, jade, serpentine, jasper, basalt, and other stones. Many of them are so slightly and roughly manufactured that they might of themselves escape notice; but some, and of these some in each important locality, are distinctly cut into definite shapes, always nearly the same, and corresponding in appearance with the hard stones still used by various savages for arrow-heads, axe-heads, lance-heads, and rough knives. Some few are even more carefully finished and smoothed. The most numerous are flakes of flint apparently intended for knives. The most perfect are oval or almond-shaped stones. So large a number of them have been found in certain spots as to lead to the supposition that they have been intentionally buried, or that a manufactory of them existed there.

The chief localities for these objects, at first, were two or three gravel beds on the banks of the Somme, near Amiens and Abbeville, in France. Many caverns and some gravel beds in the southern and western parts of England have since yielded them. They have been found also in Belgium, Germany, and Italy, always with the same associations.

The evidence of their being of the age of the gravel deposit is varied and fragmentary, but on the whole satisfactory. In the first place, the gravel is undisturbed, and it is clear that all parts of the deposit must have been placed where we find them at some one time, and have since been covered up by a natural accumulation of subsoil and soil. The flints are found not at the top, nor always near the top, but occupying a definite place in the mass either with or below the bones of extinct quadrupeds, such as elephants and rhinoceroses. The naturally broken and rolled flints are weathered generally in a particular way, and these sculptured flints are weathered in the same way and to the same extent. The gravel occupies a position so much above any water level in the neighbourhood, that the general level of the whole land must have changed since the deposit, to account for its accumulation. In the case of the caverns, the implements are found sealed up with extinct bones, by a natural incrustation of limestone, and then, after being thus sealed up, deposits of more recent date have been heaped upon them. In some cases the implements have been found under the bones of animals that have either died on the spot or been dragged into the cave while undecomposed. Among such animals are bears, hyænas, rhinoceroses, elephants, and hippopotamuses, of extinct species. Horns of reindeer, on which are etched recognisable figures of the reindeer, have been found with implements and human bones in the South of France.

As a general result of this curious enquiry, it would seem that there must have been human inhabitants—savages like those of Australia, or half-civilised men like the Indians of North America—for a period so enormously more distant than the most ancient historic event, that the imagination shrinks from the consideration of the question. The actual bones of such men have been found, though rarely; but owing to a disinclination to consider the evidence, they have till lately been neglected.

Float Boards. The boards fixed to the rim or outer circumference of undershot wheels, which receive the impulse of the water and communicate the motion to the wheel.

Float Stone. [illegible]

Floated Lath and Plaster. In [illegible]

Floated Work. In architecture, [illegible]

Floating Battery. [illegible]

Floating Meadows. [illegible] of water with which they can be [illegible] The water is [illegible] in the winter season, when it [illegible] and [illegible] as a kind of manure. It [illegible] and when the plants require [illegible] as well as by preserving a higher temperature in the surface soil than it would maintain through the winter if fully exposed to the action of the atmosphere, because, whenever water is in a fluid state, its mean temperature, and that of the bodies immediately in contact with it, must be above 32 degrees, and at that temperature the grasses common in British meadows will grow. There are [illegible] benefits which grass lands receive from being covered with water during a portion of the winter season, but these have not yet been satisfactorily explained.

Floating Screeds. In Architecture, strips of plaster arranged and nicely adjusted for guiding the *floating rule*. [FLOATED WORK.]

Flocci (Lat.). In Botany the woolly filaments that are found mixed with the sporules of many Gasteromycetous Fungi. Also any wool-like hairs; hence the term *floccose*, applied to plants covered with loose woolly hairs.

Floccillation (Lat. *floccus*, *a lock of wool*). Picking the bedclothes. This is an alarming symptom in many acute diseases.

Floccus (Lat.). In Mammalogy, the tuft of long flaccid hairs which terminate the tail.

Floe. A name given to the surface ice which at the end of an Arctic winter is borne at the mercy of the winds over the ocean.

Flood. [DILUVIUM.]

Floodgate. A door, or gate, placed at the point of discharge of a large land drain, or sewer, into a river, for the purpose of allowing the escape of the inland waters, during the intervals of the tides, or of the high waters in the rivers. Generally speaking, they are exe- [illegible]

Floor. [illegible] In architecture [illegible] of an apartment. [illegible] the boards themselves. [illegible] in which the floor boards are [illegible] the whole length of the floor [illegible] those in which the boards are so laid that [illegible] continuous line [illegible] the length; they are generally [illegible] their fixing must be effected by the use of [illegible] *Herring-boned floors* are those in which the floor boards are laid in short lengths at an angle of 45 degrees [illegible] principally used for [illegible] doors [illegible] *floors* are those in which a thin slip of wood, or metal, is inserted between the horizontal joints for the purpose of impeding the transmission of the dust, and for impeding the turning up of the edges of the boards. [illegible] are principally used for warehouse floors.

FLOOR. The lower part of a ship's bottom.

Floor Cloth. This useful and ornamental manufacture originated in this country about the year 1740, when a manufactory of it was established at Knightsbridge, near London. It was originally made of narrow canvas sewn together like sail cloth, to which successive coats of paint were applied; but the seams proving inconvenient, a canvas was wove for the purpose, about four yards wide; it was then extended to seven yards in width, and afterwards to nine. The manufactory at Knightsbridge is one of the largest establishments of the kind; the dimensions of the oil cloths produced there being twenty yards by eight, and thirty yards by seven. These canvases, being stretched upon frames, and accessible over their whole surface by stages erected for the purpose, render the large dimensions of the manufactory requisite. The canvas being duly strained is rubbed with pumice stone, which renders its surface smooth and even, and then brushed over with a weak solution of size; when this is dry, the first coat of oil colour is laid on, not with brushes, but with trowels, something in the manner of plastering; when this is dry, a second coat follows it; and in this way six coats of paint are usually applied in succession, two on the back and four on the front. When

the cloth in this state, and of one colour, is sufficiently dry, it is removed from its frame upon a large roller, and carried to the upper part of the building to be *printed*; that is, to receive its pattern. This was originally effected by a process of stencilling; but in the year 1780 the great improvement of *block-printing* was introduced, by which the colours are more correctly laid on, and in greater body and variety. The printing table, which is about thirty feet long, four wide, and two feet six inches high, is firmly constructed of deal timbers laid edgeways and clamped together, the surface being truly planed; the roll of painted cloth is placed underneath it, and as it is unrolled it gradually passes over the table, where it is printed, and is then drawn forward so as to hang perfectly free while drying, the height of the building being such as conveniently to admit of this, without rolling, doubling, or folding the material, which in these stages would of course injure it. The colours, which are the usual oil colours very carefully prepared, are put on in succession with wooden blocks, which are made of pear-tree, box, or holly wood, and upon which the patterns are cut in relief; they are about eighteen inches square, and are applied in succession over the whole of the surface of the cloth lying upon the printing table. Every colour is put on by a separate block, and much dexterity is required in so placing them that the patterns may correctly interlace and join each other, without in any case overlapping or interfering: to effect this the workman is aided by guide pins, or *pitches*, as they are termed, which direct him in placing the block. The colours are first brushed or tiered upon hard cushions, from which they are transferred to the block, and thence to the cloth; and, though many are often required, it is astonishing how much effect is sometimes obtained by the judicious arrangement or mixture of two only, upon a third, which forms the ground. It will be obvious, from what has been stated, that the weight of the finished oil cloth, as compared with the naked canvas, is no unimportant criterion of its goodness; each square yard when finished weighing from four to five pounds: this distinguishes a good oil cloth from those which are vamped up and stiffened with size and other perishable materials.

Independent of the common application of oil cloth, it is not unfrequently advantageously employed as a roofing material, especially for covering verandahs and other light structures. When used for this purpose, the canvas should be made of picked long flax, and thoroughly saturated with good oil paint; it will then stand our climate and last for fourteen or fifteen years. [KAMPTULICON.]

Flora. In Astronomy, a planet belonging to the group between Mars and Jupiter. [ASTRONOMY.]

FLORA. The plants peculiar to any country constitute its flora. [FAUNA.]

Floral Envelopes. In Botany, this term is applied to the calyx and corolla if both are present, or to the calyx when there is only one. These parts envelope or protect the more essential organs, stamens and pistil.

Florets. The flowers of a capitule or anthodium; which are often smaller in size, but not different in structure from ordinary flowers. Those which are placed in the middle of the capitule are called *discoidal*, or *of the disc*; those in the circumference are named *radiant*, or *of the ray*.

Florin. [MONEY.]

Flos-ferri (Lat. *flower of iron*). A coralloidal carbonate of lime, often found in veins of spathose *iron* ore.

Flota. A name given by the Spaniards to the ships that formerly sailed together, or under convoy, from Cadiz and the other ports of the Peninsula authorised to trade directly with the Transatlantic possessions of Spain. The word is identical with our *fleet*.

Flotilla (Span.). Literally, *a little fleet*; in which sense, however, it is seldom used, being applied almost invariably to a fleet, how large soever, composed of small vessels. Thus the term *flotilla* was given to the immense naval force with which Napoleon meditated the invasion of Great Britain, and which consisted of 2,365 vessels of every description, was manned by about 17,000 sailors, and carried 160,000 soldiers with 10,000 horses. In Spain, the name *flotilla* is given to a number of vessels appointed to announce to the home government the departure and nature of the cargo of the flota or mercantile ships from foreign ports on their homeward voyage.

Flotsam (floating), **Jetsam** (Fr. jeter, *to throw*), and **Lagan** (lying), as Law terms, are usually joined together. The first, according to Blackstone, designates goods cast from a ship and swimming in the waves; jetsam, goods cast and sunk; lagan, sunk but tied to a buoy by the owners. Goods in either of these three predicaments belong to the king, if the owners be not known, and may by him be granted with other franchises.

Flounder. In Ichthyology. [FLUKE.]

Flour. The finer portion of the meal to which grain is reduced by grinding. It is separated from the bran, *middlings*, *pollards*, &c., with which in *whole meal* it is mixed, by passing through sieves and *silks* which allow its passage but hinder that of the coarser meal. The following is a short description of the whole milling process.

Mill stones are circular slabs of French burr (about four feet across and nine or ten inches thick), pieced together and held in one by an iron rim. Their surfaces are made perfectly true planes; they are pierced at the centre by two circular eyes about six inches in diameter. The lower one is fixed and firmly bedded; the upper one hangs balanced on cross bearings on the end of the vertical shaft (passing through the eye of the lower one), by which it is driven. It is furnished with four leaden plugs around its upper circumference, by additions to which it can be accurately balanced, and the shaft is

then lowered until the two surfaces are on the point of touching one another. The grain is fed into the interval between them through the eye of the upper stone; and the centrifugal tendency consequent on its revolution, together with blast and exhaust respectively where Bovill's patent is employed, drives it from the inner to the outer edge of the grinding surfaces, the grain being reduced to flour and bran on its way. In order to accomplish this result, the surfaces of the stones are furrowed, so that both rubbing and cutting are combined in the process of grinding.

In the first place each surface is scored with ten tolerably deep equidistant radial grooves, and thereafter the angular sections thus defined are tooled with straight and equidistant close and shallow furrows chipped out, which are not radial, but which are parallel to the foremost of the radial sides of each section as the whole revolves. When this one surface revolves over the other, which it does at the rate of about 120 revolutions per minute, the scorings of the under and upper surfaces cross one another and produce a cutting as well as a rubbing of whatever lies between them, while their action tends somewhat to check the rapidity of the centrifugal action upon the still unground fragments of the berry of wheat which have yet to be reduced to flour. A week's grinding so far obliterates these markings on the stones as to require them to be redressed. A steel straight-edge is used by which to make wooden ones, and the latter when thus made absolutely true indicate by means of paint any faults of surface in both the stones, and thus in retooling the scores upon the stones the perfect truth of the surfaces employed is insured. A good stone will wear not more than an inch in seven years.

The further process is best described by means of a particular example. As the flour and bran, &c., leave the stones, they fall down a tube into the floor below, and the whole is then received by a horizontal tube with screws, which conveys it along to the various lifts by which it is carried up into an upper floor, where it is dressed, i. e. separated into the various qualities, bran, pollards, &c., and fine flour; and thence it drops into the flour rooms or *pastries*, from which it drops into sacks.

The dressers are *silks*—cylinders of silk, of varying texture, in this instance thirty-six feet long, and about three feet in diameter, stretched upon octagonal frames, revolving at the rate of twenty-six per minute—into which the whole meal is received, and through which the flour passes into the *pastries* below, while the bran is delivered into shoots and carried by lifts, &c., to the store, whence it is delivered for sale. In this way the whole produce of the stones is separated into the various sorts and qualities known in the market, which have been already enumerated. It must be added that before wheat is delivered to the millstones, it is cleaned, in fact *scrubbed*, in order to get rid of bunt and smut, riddled to get rid of chaff and weed seeds, and various qualities are mixed so as to insure flour of the *strength* and character desired. [BREAD.]

Flower (Lat. *flos*, Fr. *fleur*). In Botany, the term applied to that assemblage of organs of which the stamens or pistils, or both, form part. In many, indeed most, cases these are enclosed by two whorls called *calyx* and *corolla*, but the latter are not essential to the idea of a flower.

Flowerless Plants. Those plants that are destitute of flowers and sexes. They are the same as *cryptogamic*, or *acrogenous*, or cellular plants.

Flowers. The old chemists gave this name to several light flocculent substances obtained by sublimation; such as *flowers of sulphur*, *flowers of benzoin*, &c.

Fluocerine or **Fluocerite.** The native fluoride of cerium, occurring near Fahlun, in Sweden.

Fluellite. Native fluoride of aluminum, occurring at Stennagwyn, in Cornwall.

Fluent or **Flowing Quantity.** In Analysis, the variable quantity, considered as increasing or diminishing. The term denotes the same thing as *integral*, which is now universally used in its stead, the differential and integral calculus having superseded the methods of fluxions and fluents. [FLUXION, INTEGRAL.]

Fluid or **Fluid Body.** A body whose parts yield to the smallest pressure, and are moved among each other without any sensible resistance.

Fluids are of two kinds, elastic and non-elastic. The mechanical properties of elastic fluids, comprehending air and the different gases, constitute the science of *Pneumatics*; those of the non-elastic fluids, water, mercury, &c., *Hydrostatics* and *Hydraulics*. It is to be remarked, however, that the terms *elastic* and *non-elastic* are here used in a relative, not in an absolute sense; for water, alcohol, and probably all other fluids of the same class, are, to a certain extent, compressible and elastic, though they resist compression with a very great force.

Fluid Ounce. [MEASURES.]

Fluidity (Lat. fluidus, from fluo, *I flow*). That state of a substance in which its constituent particles are so slightly cohesive that they yield to the smallest impressions. The term is usually confined to express the condition of the so-called non-elastic fluids; and hence it denotes one of the three states in which matter exists: namely, the solid, the fluid or liquid, and the gaseous. The state of fluidity is best defined as that in which bodies tend to form *drops*, as this disposition does not belong either to bodies in a gaseous form, or to solid bodies reduced to fine powder. The formation of drops arises from this—that the molecules of fluid bodies adhere to each other with a certain force, while at the same time they glide over one another without any sensible resistance. It is incorrect to say that the molecules of bodies in a state of

fluidity offer no resistance to separation; for, on bringing a flat disc of glass or metal into contact with the surface of a liquid, a very sensible degree of force is required to separate them. That adhesion exists among the molecules of fluid bodies, is also proved by various other phenomena. Water or mercury on a flat plate of metal collects in globules, and when slowly poured into a wineglass will remain heaped up as it were above the level of the edge.

Fluke. A name commonly applied to a species of flat fish, or *Pleuronectes*, also termed *flounder*; and also to an *Entozoon* of a similar form (*Distoma hepaticum*), which infests the ducts of the liver of different animals, especially of the sheep.

FLUKE is also applied in Navigation to the broad pointed part of the anchor which takes hold of the ground.

Fluoboric Acid or **Fluoride of Boron.** A gas obtained by heating to redness a mixture of dry boracic acid and powdered fluor spar. Its specific gravity is 2·36. It is colourless, pungent, and produces a dense white cloud when it escapes into a moist atmosphere; it is resolved by the action of water into boracic and hydrofluoric acids. It acts with great energy upon animal and vegetable substances, and chars them. It is a compound of one atom of boron and three atoms of fluorine.

Fluor Spar. A common mineral product, which frequently constitutes a large part of the contents of metalliferous lodes, and of veins in clay-slate. In many mines of Devon and Cornwall, especially in some of those situated in or near granite, it forms an important constituent of the matrix of the copper ores. It is generally crystallised in cubes, but the primary form is a regular octahedron. It is a fluoride of calcium, composed of 51·3 per cent. of calcium and 48·7 fluorine. The colours are very various, but generally white, grey, or tints of blue, green, purple and yellow. The varieties found in Derbyshire are known in this country under the name of *Derbyshire Spar*, and locally by the miners as *Blue John*. These are often beautifully banded, especially with blue and purple, and are much prized for the manufacture of vases; they are also occasionally made into beads, brooch-stones, and other ornamental articles. Fluor spar is also used as a flux to promote the fusion of certain refractory minerals, for which reason it has received the name it bears (from *fluo*, to flow). Small quantities of fluoride of calcium are found in some organic products, and in certain mineral waters. [FLUX.]

Fluorescence. The peculiar self-luminous appearance presented by certain substances on being viewed by reflected light. A particular kind of *fluor spar* was first observed to have this property, hence the name *fluorescence*. Decoction of horse-chestnut bark and solutions of quinine possess it in a remarkable degree. The particular rays of light reflected to the eye of an observer from fluorescent bodies are invisible except through the medium of such bodies. Even the spectrum produced by decomposing a pencil of light by a prism, gives to the unaided eye no evidence of their presence; it is only when a fluorescent body is introduced into their path that they are rendered visible. As these are refracted by the prism beyond the extreme violet, their frangibility is reduced to such an extent as to bring them within the limits of the visible spectrum.

Fluoric Acid. [HYDROFLUORIC ACID.]

Fluorine. The hypothetical base of the fluorides and hydrofluoric acid: it has not yet been obtained in a separate state.

Fluosilicic Acid. A gas obtained by applying a gentle heat to a mixture of one part of powdered fluor spar, one of silica, and two of sulphuric acid, in a retort. It is colourless, pungent, fumes when it escapes into a humid air, and is rapidly absorbed by water. Its specific gravity is about 3·6; 100 cubic inches weighing nearly 112 grains. It is decomposed by water, and forms silica and hydrofluoric acid. It consists of 22 parts by weight of silicon and 57 of fluorine, its equivalent (upon the hydrogen scale) being 79.

Flush. In Architecture, the continuance in the same plane of the surfaces of two contiguous bodies is expressed by saying that they are *flush*; this is irrespective of the direction of the fibres or grain.

FLUSH. In Maritime language, refers to the deck of a ship, and signifies that it extends without break of level from stem to stern; as in a frigate.

Flutes. In Architecture, the upright channels on the shafts of columns, usually ending hemispherically, at the top and bottom. Their plan or horizontal section is sometimes semicircular, or segmental, or elliptical, as in some examples of Grecian architecture. The Doric column has twenty flutes round its circumference; the Ionic, Corinthian, and Composite, have respectively twenty-four; the Tuscan column is never fluted, but it is occasionally CABLED [which see].

Fluviales (Lat. from fluvius, *a river*). A natural order of Endogenous water plants common in all extra-tropical countries, and approaching somewhat to flowerless plants. They belong to the Hydral alliance, and are specially marked by their hypogynous stamens, globose or filamentous pollen, free ovary, and complete embryo. Pollini, according to De Candolle, asserts that spiral vessels exist in them, while Amici urges the contrary. Their sensible properties are unimportant. *Zostera* or Sea Wrack, one of the genera, is used to stuff cushions, and as a material for packing. The order is often called *Naiadaceæ*, and according to the above definition includes also *Zosteraceæ*.

Flux (Lat. fluxus, *flowing* or *loose*). Applied in technical Chemistry to substances which are in themselves very fusible, or which promote the fusion of other bodies. When tartar is deflagrated with half its weight of nitre, a mixture of charcoal and carbonate of

[illegible]

Flying Fish. The species of two [illegible] genera of fish in which the pectoral fins [illegible] developed as to enable them to sustain [illegible] for a short time in the air, are so [illegible]. The more common species are the Mediterranean flying fish (*Exocoetus* [illegible]) and the [illegible] gurnard (*Dactylopterus* [illegible]).

The word *exocoetus*, Gr. [illegible], [illegible] denotes an animal which comes out of the sea to sleep, and would thus be applied to seals, walruses, &c.

Flying Jib. In Navigation, a triangular sail set outside, i.e. before, the jib.

Flying Sap. In Military Engineering, the rapid excavation of the trenches of an attack, when each man advances under cover of two gabions.

Flysch. A name given to a part of the great nummulitic formation in the Alps, where

[illegible] The method was invented by Newton, and his notation was adopted by all English writers, and long obstinately adhered to, although the notation of Leibnitz, the inventor of the differential calculus, possesses over it many advantages, particularly in the more abstruse theories of analysis.

The best systematic *Treatise on Fluxions* is that of Maclaurin, published at Edinburgh in 1742; the first treatise on the subject, in our language, in which the differential notation was employed throughout, was the article

ie rock passes into metamorphic limestones, nd even into crystalline mica schists and neiss. These beds are not always limestones, ven when loaded with fossils of foraminifera. NUMMULITIC FORMATION.]

Fo. The name given by the Chinese to Buddha. Originally the name Buddha was expressed in the Chinese language with sufficient exactness by the term Fô-thau, pronounced Fôu-dah; but, as is usual in China with proper names, the last syllable was subsequently dropped. According to the Chinese historians, the religion of Buddha was introduced into China in the reign of Ming-ti, of the dynasty of the Hans, about the sixty-fourth year of the Christian era; but there is good reason to believe that the doctrines of the Indian reformer had been carried thither before that period, and that it is only to their official recognition by the government that this later date refers. In China the same principles are adopted as in all countries where Buddhism is professed, with the exception of a few trifling deviations which the various translations of the Buddhist writings from their original Sanscrit have naturally generated. (For the results of recent researches on this subject, see *Le Bouddha et sa Religion*, by M. Barthélemy St. Hilaire.)

Focal Conics of a Quadric Surface. [FOCUS.]

Focal Lines of a Quadric Cone. [FOCUS.]

Foci of an Involution. [INVOLUTION.]

Focile Majus. In Anatomy, the greater bone of the arm or the leg, the lesser being termed *focile minus*.

Focus (Lat. *a hearth*). In Optics, the point in which rays of light are collected by refraction or reflection. A mirror, for instance, whose reflecting surface coincides with that of a paraboloid of revolution has the property of causing all rays which are incident parallel to its diameter, to pass, after reflection, through the same point. Again, in the major axis of an ellipse there are two points, such that any ray of light proceeding from the one is reflected through the other; and in the transverse axis of an hyperbola there are also two points, from either of which if rays were to emanate, they would, after reflection, proceed as if they emanated from the other. In virtue of these optical properties the term *focus* became introduced into the geometrical theory of conic sections. Subsequently it was found that these same points possessed other properties more suitable for their geometrical definition. It was found, for instance, that to each focus of a conic there corresponds a right line, known as the *directrix* or polar of the focus with respect to the conic, such that the ratio of the distances of any point of the conic from the directrix and the focus is constant. If $L=0$ represent, in rectangular Cartesian coordinates with the focus for origin, the equation of the directrix, the property under consideration is expressed by the equation $x^2+y^2=a^2L^2$. But in this form, to which the equation of every conic is reducible, we at once recognise that the two imaginary lines $x+y\sqrt{-1}$, $x-y\sqrt{-1}$ which join the focus to the circular points at infinity touch the conic. We are thus led to define the foci of a conic, and by generalisation *the foci of any curve whatever, as the points of intersection of the tangents to the curve drawn through the circular points at infinity.* For a curve of the n^{th} class there will consequently be n^2 foci; of these, however, never more than n can be real, since no imaginary tangent can pass through two or more real points. The above general definition of foci, as well as an investigation of the focal properties of cubic and other curves, will be found in Salmon's *Higher Plane Curves*.

The foregoing equation shows also that a focus of a conic may be defined as the *point-circle* which has double contact with the curve and the corresponding directrix as the chord of contact. The advantage of this definition is that it may be extended to quadric surfaces, a *focus* of which may be defined as a *point-sphere* having double contact with the surface, the corresponding *directrix* being the chord of contact. Thus (ξ, η, ζ) will be a focus, if the equation of the quadric can be expressed in the form

$$(x-\xi)^2+(y-\eta)^2+(z-\zeta)^2=AL^2+BM^2,$$

where $L=0$ and $M=0$ represent planes which intersect in the corresponding directrix, and A and B are constants. The section of a quadric made by any plane through a focus and its directrix is always a conic having its own focus and directrix coincident with those of the surface. According as A and B have unlike or like signs, the planes of contact of the point-sphere and quadric will be real or imaginary. In the former case the planes of contact are parallel to the planes of circular section of the quadric, and in the latter case the point-sphere is distinguished as a *modular focus*, since the distance from it of any point on the quadric bears a constant ratio, the reciprocal of which is called the *modulus*, to the distance of the same point from the directrix, this latter distance being measured parallel to one of the planes of circular section. It can be shown readily that every quadric has innumerable foci, all of which, however, lie in three plane conics, called the *focal conics*, situated in the principal diametral planes of the quadric. Of these three focal conics, in the case of central quadrics, one is always imaginary, one an ellipse, and the other an hyperbola. The focal conic which contains the modular foci is called the *modular focal conic*, and does not intersect the surface. On the other hand, the focal conic which contains the *non-modular foci* always intersects the quadric in its *umbilics*, and has on that account been denominated the *umbilicar focal conic*. In the case of an ellipsoid whose semi-axes are $a>b>c$, for instance, the modular focal conic is the ellipse $(\sqrt{a^2-c^2}, \sqrt{b^2-c^2})$ confocal with the elliptic section (a, b); the umbilicar focal conic being the hyperbola $(\sqrt{a^2-b^2}, \sqrt{b^2-c^2})$

confocal with the elliptic principal section (a, c) and passing through the umbilics whose coordinates are given by the equations

$$x^2 = a^2 \frac{a^2 - b^2}{a^2 - c^2},\ y = 0,\ z^2 = c^2 \frac{b^2 - c^2}{a^2 - c^2}.$$

In the case of cones, the focal ellipse coincides with the vertex, and the focal hyperbola degenerates into two right lines through the vertex which take the name of *focal lines*. The numerous properties possessed by the foci of quadric surfaces were discovered independently and at about the same time by Chasles and M'Cullagh (*Aperçu Historique* and *Proceedings of Royal Irish Academy*, vol. ii.). Townsend in the *Cambridge and Dublin Mathematical Journal*, vol. iii., and Salmon in his *Treatise on Surfaces*, have also given able expositions of these properties.

Focus of a Plane. [KINEMATICS.]

Fodder (A.-Sax. voder, Ger. futter, *food*). In Agriculture, whatever is given to cattle as the ordinary food is designated *fodder*; whereas corn, beans, and other articles, which present nourishment in a more concentrated form, are not included under the term *fodder*, but are rather known as *solid food*.

FODDER. The name of a weight formerly used in the weighing of lead: it was of various magnitudes, but most commonly amounted to about 2,400 lbs.

Foeniculum. [FENICULUM.]

Foetus (Lat.). From about the fifth month after pregnancy till the period of its birth, the child in the womb of its mother is termed a *fœtus*.

Fog (Dan.). In Meteorology, a cloud resting upon or near the surface of the land or water. Fogs, in general, are the consequence of the cooling of atmosphere. When humid air is cooled, a part of its moisture separates in the form of visible vapour or fog. During the day the heat of the sun generally disperses the fog, because the quantity of moisture which the air is capable of holding becomes more considerable in proportion as its temperature is increased; and thus as the temperature rises, the globules of water constituting the cloud gradually assume the form of true vapour, which is always transparent and invisible.

In calm weather the surfaces of rivers, lakes, &c. are frequently in the morning covered with fog. The reason is this: During the night the air is colder than the water; the strata of air in contact with the water are consequently heated, and become saturated with moisture. The mixture of the vapour with the air, together with its higher temperature, renders it specifically lighter. It rises in consequence, and mixing with the cold air in the superior strata, is cooled, and precipitates moisture. The cloud or fog resulting from this precipitation can only rise to a small height, because the uniformity of temperature is soon restored. Hence it is easy to see how winds, or agitation of the air, prevent the formation of fogs over the surface of water. In the equinoctial regions, fogs sometimes continue during a considerable part of the year. Humboldt relates that Lima is often covered with a fog half the year, especially in the mornings and evenings; and that along the whole of that coast fogs supply the place of rain, which is extremely rare. In the polar seas thick fogs often prevail even during the warmest months; and they are so dense that objects frequently cannot be distinguished at the distance of a few yards.

Sometimes, though rarely, fogs occur of which the cause is not well understood. In 1783, the whole of Europe was covered with fog during nearly two months. On May 22, 1822, about five o'clock in the afternoon, a fog covered Paris and the neighbourhood, which had the odour of nitrous gas: it continued about an hour. The yellow fogs of London derive their tint and odour from coal-smoke. The dust, ashes and vapours of volcanoes sometimes occasion peculiar forms of fog, extending over large and even distant districts. The dry fogs, or hazes, in which no precipitated moisture is present, have as yet been very imperfectly investigated.

Fog-rings. Banks of fog arranged in a circular or ring-form; a meteorological phenomenon not unusual on the coast of Newfoundland. (*British Association Report for* 1846.)

Foil (Fr. feuille, Lat. folium, *a leaf*). This term is generally applied to varnished metal. Common foil is manufactured as follows: A copper plate, covered with a thin layer of silver, is rolled out into sheets under the flatting mill; the silver surface is then highly polished and covered with a colourless varnish. The *coloured foils* are similarly prepared with coloured varnishes.

Foils. Thrusting swords with covered points using in fencing.

Folcland. [BOCLAND.]

Fold (A.-Sax. fald). A temporary enclosure for keeping agricultural animals together, either for the purpose of protection during night, or jointly for protection and feeding. Sheep are sometimes folded for the purpose of manuring. Folds are commonly constructed with wooden hurdles; but sometimes, when the fold is only to contain ewes and lambs, netting stretched between posts is made use of, a strong rope being fixed to the lower parts of the posts close to the ground, to which the under edge of the netting is attached, while its upper edge is attached to a rope stretched along the tops of the same posts. The practice of folding sheep on naked fallows, with a view to manuring them, is still common in several parts of England, and the South Down breed of sheep is especially adapted for it.

Foliage (Lat. folium, *a leaf*). In Architecture and Sculpture, a group of plants and flowers so arranged as to form architectural or sculptural ornaments; as in friezes, panels, architraves, &c., and also in the capitals of the Corinthian and Composite orders, in Gothic capitals, finials, crockets, &c.

Foliation. One of those structural phenomena of rocks, the origin of which is obscure, but which are so large, and range so widely, that they must belong to the action of some important law. Gneiss, hornblendic schist, mica schist, and even porphyries and basalt are often thus foliated, separating into plates of definite thickness. Very remarkable examples of foliation are described by Mr. Darwin as occurring in South America.

FOLIATION. In Botany, the manner in which the nascent leaves are arranged within a leaf-bud.

Folio (Ital. *a leaf*). In Account-books, signifies *page*. Thus *folio* 7—written abridgedly *fo.* 7—denotes the seventh page; *folio recto*, or F° R°, signifies the first page, *folio verso*, or F° V°, the second page of a leaf. A book in folio, or simply a folio, is one in which the sheet is only folded in two, each leaf making half a sheet.

FOLIO. In Printing, this term denotes the running number of the pages of a book. When there is no running head, the folios in Arabic figures are placed in the centre of the headline, sometimes between brackets or parentheses, but now usually without; where there is a running head, the folio is put into the corner.

Foliolum. A leaflet borne upon the axis of a leaf.

Folium of Descartes. A curve of the third order defined by the equation $x^3+y^3=3axy$. It has a double point at the origin, and is consequently a cubic of the third class. The equation of its asymptote is $x+y+a=0$.

Folkmote. Among our Anglo-Saxon ancestors, signified any popular or public meeting of all the folk or people of a place or district; for instance, of all the tenants at a court leet or court baron, or of all the freemen of the county, or of all the barons of the kingdom. Antiquaries are, however, by no means agreed as to the nature of the folkmote; some considering it an institution of great, others of minor importance.

Follicle (Lat. folliculus, *a small sack*). In Anatomy, this term is applied to a simple gland, consisting merely of a hollow vascular membrane and an excretory duct: hence the term *mucous* and *sebaceous follicles*.

Folliculus (Lat.). A one-celled, one or many seeded, one-valved, superior fruit, dehiscent by a suture along its face, and bearing its seeds at the base, or on each margin of the suture; it differs from the legume in having but one valve instead of two.

This term has also other significations; viz. 1. According to Linnæus, any kind of capsule. 2. The cases bearing the reproductive organs of *Equisetaceæ*. 3. According to Gærtner, a double, one-celled, one-valved, membranous, coriaceous capsule, dehiscing on the inside, and either bearing the seed on each margin of its suture, or on a receptacle common to both margins; as *Asclepias*, &c. 4. According to Wildenow, any obl.ng pericarp bursting longitudinally on one side, and filled with seeds; as *Vinca*.

Fomalhaut. A star of the first magnitude in Piscis Australis.

Fomes (Lat.). In Medical language, this term is applied to porous substances capable of absorbing and retaining contagious effluvia. Wood and woollen clothes are said to be active *fomites*.

Font (Lat. fons, *a fount*). In Architecture and Sculpture, a vessel, generally of stone or of marble, for the purpose of containing the water of baptism in the Christian church. The fonts of Ewelme; All Saints', Norwich; Bradford Abbas, and Walsingham, may be mentioned as splendid specimens for the richness of their decoration and the character of the designs. (Paley *On Baptismal Fonts*; Simpson, *Baptismal Fonts*, &c.)

Font of Type. [FOUNT.]

Fontanel. The interstice or *mould*, as it is often called, which exists at birth between the frontal and parietal bones: it is closed by bony matter about the end of the third year.

Food (A.-Sax. foda). All substances susceptible of digestion and assimilation may come under the denomination of *food*; but the proximate principles of organic bodies on which their nutritive powers depend are comparatively few. Hence, although the articles employed in different countries for the support of animal life are almost infinitely various, their sustaining powers may be referred to certain substances capable of being separated and identified by chemical analysis and tests. Amongst the proximate elements of vegetable food, gluten and its modifications, starch, gum, sugar, and lignin or woody fibre, are the most important; and amongst those of animal food, fibrin, albumen, gelatine, and their modifications; together with fats and oils, which are common to both kingdoms of nature.

To illustrate the actual simplicity of our food as compared with its apparent multifariousness and complexity, it may suffice to state, that, as regards vegetable food, wheat and almost all the esculent grains consist principally of starch and gluten; that the same ingredients are found in many fruits and roots; that sugar, gum, or a relation of gum which is called *vegetable jelly*, together with minute traces of aromatic principles which give flavour, and more or less abundance of water and of vegetable acids, are the chief component parts of apples, pears, peaches, currants, gooseberries, and all analogous tribes of fruits; a very few also contain oil. Then, as regards *animal* food, the muscular parts of various animals closely resemble each other in composition and nutritive power; in some cases texture merely, and in others minute additions of foreign matters, confer upon them their relative digestibilities, and their different aspects and flavours: albumen or fibrin, and gelatine, small proportions of saline bodies, and a large quantity of water are found in them all.

It often happens that the truly nutritious part of food is so combined with or protected by indigestible matters, as to escape the sol-

vent powers of the stomach, unless previously prepared and modified by various chemical and mechanical agents. Indurated woody fibre, for instance, or *lignin*, will often resist the joint action of the stomach and bowels, and pass through the alimentary canal with scarcely any alteration. The husks of many seeds and fruits are composed almost exclusively of this material. This is the case with the kernels of the apple, pear, &c.; the seeds of the currant, gooseberry, melon, and so on; the skin or husk of peas, beans, &c., and of wheat, barley, and oats; so that unless this woody part is either broken down by the teeth, or previously removed, the food which it envelopes is protected from the solvent action of the secretions of the stomach. This is in some respects a wise and curious provision in nature; for birds in this way become the carriers of seeds, which pass through them not only undigested but even retaining their vegetative powers; and in this way uninhabited and sterile portions of the globe may gradually become clothed with verdure, and shrubs and trees. Bones are highly nutritive; but unless broken into very small fragments by the masticatory powers of the animals which eat them, they cannot be digested. In reference, however, to the food of man, much of its digestibility and nutritious power is referable to the important chemical operations, preparatory to its use, which are carried on in the kitchen: in other words, cookery is essentially a chemical art; and substances totally unfit in their raw state for reception into the stomach, are rendered palatable, digestible, and nutritious, by the skill of the cook. And here salt, and a variety of *condiments*, as they are called, and which are aromatic and stimulant substances chiefly of vegetable origin, play an important part; nor must the mere effect of heat be overlooked, for it is most important. Meat, by proper boiling and roasting, is not only softened in its fibre, but new substances are generated in it. Among these a peculiar extractive matter, and *osmazome*, or the principle which gives an agreeable flavour and odour to dressed meat, are especially recognised. Nor are the changes which vegetables suffer under the influence of heat less obvious.

There is another important point in the history of our food, namely, its *ultimate composition*. We have spoken of starch, sugar, gum, albumen, and other substances, as the *proximate* principles upon which we live; but what is the *ultimate* constitution of these secondary products—what are their true *elements*? It is curious that four *elements* only are principally concerned in the production of our food. These are carbon, hydrogen, oxygen, and nitrogen; and of these the bulk of our food is composed: but sulphur, phosphorus, lime, iron, and several other substances must also be present in it. Among vegetable substances gluten (including vegetable albumen) is the only one which abounds in nitrogen; gum, sugar, starch, and the rest are constituted of carbon, hydrogen, and oxygen only; and what is very remarkable is, that in all these important principles, and also in lignin, the oxygen and hydrogen bear to each other the same relative proportions as in water, so that they may be figuratively described as compounds of *charcoal* and *water*. Now there are two very curious points in reference to that part of the chemical history of our food which has been adverted to: the one is, that no animal can subsist for any length of time upon food which is destitute of nitrogen; and the other, that a certain mixture of different kinds of food is absolutely essential. An animal fed *exclusively* on starch, or sugar, or albumen, or jelly, soon begins to suffer in health; peculiar diseases make their appearance, and his existence is painful and brief; but mix these together, and occasionally modify their proportions, and he then thrives and fattens. Magendie's experiments on this subject, together with those of Tiedemann and Gmelin, well illustrate this fact. Thus, geese fed upon gum died on the 16th day, those fed upon starch on the 24th, and those fed on boiled white of egg on the 46th; in all these cases they dwindled away and died as if of starvation. Physiologists have also made similar experiments upon dogs and other animals with the same result.

Habit, as is well known, will do much in accustoming the stomach to particular kinds of food; many persons live exclusively, or almost so, on vegetable, others on animal matters, and particular kinds of diet are forced on the inhabitants of many regions of the globe: but, as far as we are concerned, a due mixture of vegetable and animal matter is not only most palatable, but most conducive to health. Nothing is fit for food which has not already undergone organisation; and *water*, though an essential part of the food of all animals, is obviously not in itself nutritious, though it performs the extremely important function of dissolving nutritive matter, so as to render it conveyable by the lacteals and other absorbents into the blood. No compound then of nitrogen, hydrogen, carbon, and oxygen, which can be formed artificially, can constitute food. Air, water, and charcoal, though involving the principal *elements* of our nutriment, are themselves unfit for our support; and it is only by passing through the hidden processes which are carried on in the vessels of living things, that they are so recombined and modified as to be rendered capable of supporting animal life. It is the vegetable world which commences this wonderful operation. Plants absorb their nutriment from the air and from the soil; they assimilate inorganic matter; they become the food of the graminivorous tribes, and from these man derives the great bulk of his animal food.

In speaking of the composition of food, that of *milk*, the most important of all food, must not be forgotten; in it nature has wonderfully provided a mixture which, though secreted by an animal, partakes also of the nature of vegetable food, and it presents a perfect analogy to

that combination of vegetable and animal matter which has been mentioned as most congenial to the palate and stomach. The caseine or *curd* of milk is a highly elaborated animal principle, abounding in nitrogen, yet, from its attenuated and soluble state, easy of digestion. A second principle of milk is what is termed *sugar of milk*; in composition and properties it resembles a vegetable product, and is intermediate between gum and sugar. The third component of milk is *butter*, partaking of the nature of vegetable oil and animal fat; there are also certain saline and other substances in small proportion; and all these matters are either dissolved or suspended in a large relative proportion of water.

I. *Table showing the average quantity of nutritive matter in* 1,000 *parts of several varieties of animal and vegetable food.*

Blood	215	Carrots	98
Beef	260	Turnips	42
Veal	250	Cabbage	73
Mutton	290	Beetroot	148
Pork	240	Strawberries	100
Brain	200	Pears	160
Chicken	270	Apples	170
Cod	210	Gooseberries	190
Haddock	180	Cherries	250
Sole	210	Plums	290
Bones	510	Apricots	260
Milk	72	Peaches	200
White of egg	140	Grapes	270
Wheat	950	Melon	30
Rice	880	Cucumber	25
Barley	920	Tamarind	340
Rye	792	Almonds	650
Oats	742	Morels	896
Potatoes	260		

The above table represents the relative proportion of solid digestible matter contained in 1,000 parts of the different articles of food which are enumerated. When blood, for instance, is evaporated to dryness, at a temperature not exceeding 212°, the residue amounts to 215 parts in 1,000, and may be regarded as almost entirely composed of digestible matters; it consists chiefly of albumen and fibrin with small proportions of other substances. The loss of weight in the different kinds of meat during their desiccation is almost wholly referable to water; and the dry residue composed of albumen, fibrin, gelatine, and traces of fat, and of saline matters, represents the true nutritive value. Upon an average, therefore, the nutritive matter in a pound of meat is not more than four ounces. This, however, only applies to raw meat; for when dressed a considerable portion of its constituent water is often dissipated. The nutritive matter of wheat is chiefly starch and gluten, and in this species of grain the gluten is in greater relative proportion to the starch than in barley, oats, or rye. In rice starch predominates. There can be little doubt that the great value of wheat as an article of food depends upon this excess of gluten, which is a nitrogenous substance, and has not inaptly been termed the vegeto-animal principle. In the esculent roots, such as carrots, beet, parsnips and turnips, sugar is a leading nutritive matter; and the common fruits contain sugar, gum, albuminous matter, and acids, together with a highly attenuated form of woody fibre, or lignin, which, in that state, is probably digestible.

The following table shows the relative proportions of the carbon, hydrogen, oxygen and nitrogen which have been above adverted to as constituting the nutritive part of food: their supposed functions in a physiological point of view will be noticed under the head NUTRITION.

II. *Table showing the ultimate elementary composition of* 1,000 *parts of the following proximate principles of animal and vegetable food.*

	Carbon	Hydrogen	Oxygen	Nitrogen
Albumen	516	76	258	150
Gelatin	483	80	276	161
Fat	780	122	98	
Curd of milk	609	73	116	203
Sugar of milk	454	61	485	
Gluten	557	78	220	145
Starch	438	62	500	
Gum	419	68	513	
Sugar	444	62	494	
Lignin	500	56	444	

Fool's Parsley. An umbelliferous plant, common in waste ground, and so called from its having sufficient resemblance to plain or uncurled parsley to deceive ignorant persons. It is a poisonous plant, acting like hemlock upon the human system; and is easily known by the involucels having each three leaflets, which are always placed next the circumference of the umbel. It is the *Æthusa Cynapium* of botanists. All risk of injury from such a plant may be avoided by using only the curled leaved variety of the true parsley.

Fools, Feast of. A festival anciently celebrated in almost every church and monastery of France on New Year's Day. It was equivalent to the Saturnalia among the Romans, whence indeed it is said to be derived. This festival received some modifications in the different districts where it was celebrated, and acquired various designations according to the various ceremonies of which it consisted. Thus it was termed *la fête des diacres soûls, des cornards, des innocents*, &c. Several bishops and councils attempted, though in vain, to abolish this festival; but at length about the fifteenth century it became less generally observed, and soon after fell into almost total disuse, though its characteristic absurdities are still maintained in the Carnival of the present times. For full details on the Feast of Fools, see the *Encyclopédie des Gens du Monde*, under the head 'Fous (Fête des).'

Foot (Ger. fuss, Gr. *ποῦς, ποδός*). A measure of length. As this term is employed in almost all languages as a linear measure, it has doubtless been derived from the length of the human foot. Though the denomination is the same, the measure itself varies considerably in different European countries. [MEASURES.]

FOOT. In Prosody, a measure consisting of two, three, or four syllables, long, short, or long

and short. All the combinations of which these numbers are susceptible amount to twenty-eight; and such is accordingly the number of feet enumerated by Greek and Latin prosodists, according to the following table:—

⏑ ⏑	Pyrrhich	– ⏑ – ⏑	Ditrochæus
– –	Spondee	⏑ – ⏑ –	Diiambus
– ⏑	Trochee	– ⏑ ⏑ –	Choriambus
⏑ –	Iamb	⏑ – – ⏑	Antispastus
⏑ ⏑ ⏑	Tribrachys	⏑ ⏑ – –	Ionicus a minore
– – –	Molossus	– – ⏑ ⏑	Ionicus a majore
– ⏑ ⏑	Dactylus	– ⏑ ⏑ ⏑	Pæon primus
⏑ ⏑ –	Anapæst	⏑ – ⏑ ⏑	Pæon secundus
⏑ – ⏑	Amphibrachys	⏑ ⏑ – ⏑	Pæon tertius
– ⏑ –	Amphimacrus	⏑ ⏑ ⏑ –	Pæon quartus
⏑ – –	Bacchæus	⏑ – – –	Epitritus 1
– – ⏑	Palimbacchæus	– ⏑ – –	Epitritus 2
⏑ ⏑ ⏑ ⏑	Proceleusmaticus	– – ⏑ –	Epitritus 3
– – – –	Dispondæus	– – – ⏑	Epitritus 4

But by rejecting those which are merely reduplications of disyllabic feet (Proceleusmaticus, Dispondeus, Ditrochæus, and Diiambus), the number is reduced to twenty-four; and by also striking off those which are compounds of disyllabic feet (Choriambus, Antispastus, two Ionics, four Pæons, and four Epitrites), the number of simple feet becomes twelve only. The foot Amphimacrus is also known as the *Cretic*. [RHYTHM.]

Footings. In Architecture, the spreading courses at the base or foundation of a wall, by which the weight of the superincumbent mass is distributed over a larger area.

Footnotes. In Printing, the notes at the bottom of a page, usually set in type two or more sizes smaller than that of the text.

Footprints. Under this title we may conveniently include all the curious markings and impressions made by animals of all kinds on sands or muddy films covering sands, and owing to some favourable combination of circumstances preserved and permanently retained. There are few beds of sandstone favourably situated for such phenomena that do not exhibit them in abundance; and the subject is one of great interest.

Anyone who will watch for a time the phenomena on a tidal shore, where sands abound and clays are not far off, will find how common and varied are the markings produced; and it is not difficult to see that, though in most cases they must be obliterated by the next tide, they may possibly now and then be preserved. That they have been often retained, is clear from the *footprints* hardened and fossilised. A little blown sand and a few favourable chances of tide and time and weather seem sufficient to render them permanent.

But the markings thus made are not easily understood; we rarely know animals by their footsteps, and it is still more difficult to know them by the casts of footprints. The mark is made on soft sand; a little marly film covers it and preserves it; this again is covered with sand, and the whole becomes sandstone; but where the thin film of marl once covered the sand, there will be found on the sandstone the cast of the impression originally made on the soft sand. So accurately is this the case, that not only are the pit marks made by a shower of rain visible in certain rocks, but the direction of the wind driving the drops aslant is indicated by the more sloping side of the cast of the depression on the stone.

There is hardly a limit to the variety of these impressions. Besides those made out, many are too obscure to be even guessed at. Worm marks, and marks of soft animals of that class, which have perished entirely; scratchings of crustaceans also, lost beyond hope; and the marks of other invertebrata of which we cannot even guess at the class, are plentiful. Even the fins of fishes appear to have left their mark. But it is chiefly footprints, and trailings of the tails of reptiles, that have attracted attention. Of these, many are of gigantic size, and indicate animals of very singular proportions. Bones have also been discovered, which correspond remarkably with the indications from the footmarks. [LABYRINTHODON.]

Foramen (Lat. *an opening*). In Anatomy, a small opening. The *foramen ovale* is an opening between the two auricles of the heart of the fœtus, which closes at birth.

FORAMEN. In Botany, the opening that exists in the integuments of every ovule.

Foraminifera (Lat. foramen, *a hole*, and fero, *to carry*) or **Rhizopoda** (Gr. ῥίζα, *a root*, and πούς, *foot*). A class of *Acrita* or *Protozoa*, composed chiefly of microscopic organisms, of which AMŒBA [which see] may be taken as a type. In some the gelatinous *sarcode* substance of which they are composed develops a calcified shell, usually consisting of an aggregate of chambers, intercommunicating by minute apertures, whence the name *Foraminifera*. The last formed segment is usually distinguished by the very long, slender, pellucid, colourless, contractile filaments which have suggested the name *Rhizopoda* for the class. The minute-chambered shells of *Foraminifera* enter largely into the composition of all the sedimentary strata, especially in the chalk.

Force (Ital. forza, from Lat. fortis, *strong*). In Statics, synonymous with *pressure*. In Dynamics, force may be defined as that which produces or changes motion. Forces are measured by the velocities which they can *impart* in a given time to given masses of matter upon which they act incessantly. In accordance with experiment, it is assumed that the force necessary to impart to a given mass a given velocity, or alteration of velocity, in the unit of time, is proportional to the mass as well as to the acceleration to be produced; the unit of force, therefore, is that which is capable, by continuous action throughout the unit of time, of imparting to the unit of mass the unit of velocity. The force which acting upon the unit of mass would impart to the latter the same acceleration as that which a given body receives, is usually called the *accelerating force* acting on the body. Thus since at the earth's surface *all* bodies acquire, in every second, an acceleration of velocity amounting to 30·19 feet, we say that the accelerating force of gravity $g=30{\cdot}19$. The product of this

accelerating force into the mass of the body gives its *weight*. In dynamics the accelerating force acting at any instant on a material point which moves in a right line is expressed by $\frac{d^2x}{dt^2}$; if x denote the distance of the material point from a fixed origin at the time t under consideration, $\frac{dx}{dt}$ is its velocity at that moment, and the equations

$$v=\frac{dx}{dt},\ f=\frac{dv}{dt}=\frac{d^2x}{dt^2},$$

are called the *equations of motion*.

The product of the mass of a body into its velocity is called its *momentum* or *moving force*; it is the force which, by constantly opposing the moving body, would bring it to rest in the unit of time. On the other hand, the product of the mass into the square of the velocity is termed the *living force*, or *vis viva*. The latter may be regarded as the force which, by opposing the body incessantly throughout the unit of distance, would finally bring it to rest. The product of a force into the distance through which it is exerted gives the *mechanical work* performed by it. Hence we may say that the *vis viva* of a body is equal to double the quantity of work that would be required to bring that body to rest.

Force, Line of. In the theory of attraction, a line the direction of which, at each of its points, coincides with that of the resultant of attraction on a material particle situated at that point. The orthogonal trajectory of all lines of force is called the EQUILIBRIUM SURFACE [which see]. [POTENTIAL.]

Force of the Wind. The force of the wind is understood by some authors upon physics to express the momentum of the action exercised by the wind upon any body exposed to it. It is a source of power that is economically applied in many cases; and it requires to be taken into account in designing shafts or buildings of any considerable height in exposed situations.

Smeaton, in his papers in the *Philosophical Transactions* of the year 1757, gives the following table of the effect produced by the wind when moving with a velocity able to exercise the force quoted against it:—

Miles per hour	Feet per second	Perpendicular Force per square foot avoirdupois	
1	1·47	0·005	hardly perceptible
2	2·93	0·020	just perceptible
3	4·4	0·044	
4	5·87	0·079	gently pleasant
5	7·33	0·123	
10	14·67	0·492	pleasant, brisk
15	22	1·107	
20	29·34	1·968	very brisk
25	36·67	3·075	
30	44·01	4·429	high wind
35	51·34	6·027	
40	58·68	7·878	very high wind
45	66·01	9·963	
50	73·35	12·300	storm or tempest
60	88·02	17·715	great storm
80	117·96	31·490	hurricane
100	146·7	49·200	hurricane that tears up trees

He found that the angle at which the sails worked with the most advantage was, dividing the length of the sail into six parts, and calling them respectively from one to six—

	Angle with the Axis	Angle with the Plane of Motion
1	72°	18°
2	71°	19°
3	72°	18° middle
4	74°	16°
5	77½°	12½°
6	83°	7° extremity

In Holland, gales have been known to exercise a horizontal effort equal to a force of sixty-four pounds upon a square foot. It becomes, therefore, necessary to provide for a stability which should exceed that quantity; this is calculated by making the horizontal tendency to overthrow the building, on its outer edge, multiplied by half the height of the building, equal to the weight of it multiplied by half the base. A cylinder offers two-thirds of the resistance of a square body.

Forces, Composition and Resolution of. In Mechanics, the transformation of a given system of forces to a mechanically equivalent system. A force or pressure being defined by its *point of application*, its *direction*, and its *intensity* (relative to some chosen unit-force), it may be conveniently and perfectly represented by a finite right line, drawn from the point of application in the direction of the force, and containing as many linear units as the force represents unit-forces. The single force which is mechanically equivalent to several others taken together is called their *resultant*, and the latter take the name of *components*. The composition of forces is founded upon the following principles, whose demonstration will be found in every treatise on the subject:—

1. The point of application of any force may be removed anywhere in the line of action of that force.

2. The resultant of several forces having the same line of action acts also in the same line, on the side of those components whose combined intensities are greatest, and with an intensity equal to the excess of the sum of the latter intensities over that of the intensities of the opposite forces.

3. The diagonal of a parallelogram represents both the direction and the intensity of the resultant of the two forces which are represented by the sides drawn through one of its extremities.

The resultant of two parallel forces is parallel to each of the components, and its intensity is equal to the sum or difference of those of the components according as the latter are alike or opposite in direction. In the former case the resultant lies between the components, in the latter beyond the greater component, in whose direction it always acts. In both cases, however, the distances of the resultant from the components are inversely proportional to the intensi-

ties of the latter. According to this, the line of action of the resultant of two parallel forces having equal intensities but opposite directions would be infinitely distant, and the resultant itself would have no intensity whatever, in other words would have no existence. The mechanical effect of such a *couple of forces*, in fact, cannot be equivalent to that of any single force. Nevertheless, such couples can be combined and resolved amongst themselves according to rules precisely analogous to the three above given. [COUPLE OF FORCES.] A brief exposition of the general method of reducing to its simplest elements any system of forces acting on a body, will illustrate the advantages to be derived from the consideration of couples as well as of simple forces in statical problems.

If P be one of the given forces, and O any point or origin rigidly connected with the body, we may, without altering anything, apply at O two equal and opposite forces P and $-$P, parallel to the given one and of the same intensity. In other words, we may move the given force P parallel to itself until it acts at O, provided we introduce a couple ($P_1 - P$) acting in the plane of removal with an *arm* equal to the quantity of removal. After operating in this manner on all the given forces, and taking the resultant R of all the removed forces, as well as the resultant G of all the introduced couples, we shall have reduced the whole system to a single force of translation R, applied at O, of invariable direction and magnitude, and a single couple whose plane and moment G (moment-axis, in short) will vary in general with the assumed position of O. With respect to this *moment-centre* O, the moment of the resultant couple is called the *principal moment*, and its plane the *momental plane*.

In order that the body may be in equilibrium under the action of the several forces, both R and G must vanish; and in order that the whole system may be equivalent to a force of translation, the momental plane must pass through R. Moreover, the arbitrary moment-centre O may be so chosen that the momental plane shall be perpendicular to the direction of the resultant force R. The line of action of the force R in this case is called the *central axis* of the system. It is also the locus of moment-centres of *minimum* principal moment, and the principal moments corresponding to all centres equidistant from it are equal; the momental planes at such centres being equally inclined to the axis in question.

With respect to the numerous and important properties of momental planes and moment-centres, the works of Poinsot, *Éléments de Statique*; Möbius, *Statik*; Chasles, *Journal de Mathématiques*, tome xii.; Price, *Infinitesimal Calculus*, vol. iii. &c. may be consulted. It will suffice here to add that a system of forces may in general, and that in a great variety of ways, be reduced to two simple forces whose lines of action are not in the same plane. The lines of action of any two such forces, mechanically equivalent to a given system, are termed *reciprocal lines*, and possess many remarkable properties. The momental planes corresponding to all moment-centres situated on either, pass through the other, and both are intersected perpendicularly by a right line, which also cuts the central axis at right angles.

Forcible Entry and Detainer. In Law, a species of offence against the public peace, committed by violently taking or keeping possession of lands and tenements with menaces, arms, and force, and without authority of law, to the hindrance of him who has right of entry. The remedy is, under several statutes, by action; and by the intervention of justices of the peace, who have power, on view of the force, to make a record of it, and commit the offender.

Forcing. In Horticulture, the art of accelerating the growth of plants, so as to obtain fruits or flowers at seasons when they are not produced naturally in the open air. The practice appears to have been known to the ancient Romans; Pliny informs us that Tiberius, who was fond of cucumbers, forced them to bear fruit in the winter time by growing the plants in boxes kept in houses with talc windows, which boxes were wheeled out during fine days, and always taken into the house again at night or in cold weather. From some epigrams of Martial it has been thought that the Romans had both vineries and peach-houses; talc (*lapis specularius*) being used instead of glass.

In England, forcing appears to have been practised from a very early period; radishes having been raised on dung beds, covered during night by wheat straw, from time immemorial, and cherries having been forced on wooden walls or boarded espalier rails, heated by linings of hot dung at the back, at least from the time of Charles II., and probably long before, since it is certain that melons and cucumbers were grown at Hampton Court for the royal table in the time of Henry VIII.

Structures for forcing are known as *frames*, *pits*, and *houses*, all of which have glass roofs; but there are also structures for forcing without glass roofs, such as cellars and sheds for growing mushrooms, and also seakale, rhubarb, blanched succory, and such other stalks or leaves of plants as are eaten in a blanched state, and consequently do not require much light.

The art of forcing plants must not be confounded with the art of growing them in artificial climates, though in both cases the gardener proceeds on the same principle; viz. the imitation of nature. The chief difficulty in accomplishing this is the want of light; and hence the earlier in the season that any forced crop is produced, the greater is its deficiency in colour and flavour. Gentle forcing, so as, as it were, to anticipate spring, and bring fruits so far forward as to enable them to profit from the full influence of the sun during our short summers, may be considered as a real advantage, which will never cease to be sought for. As a case in point, we may mention the grape, the fruit of which is never brought to perfection in this country unless the plants have been partially forced.

To force, in any country, the fruits which come to perfection in the open air in that country (as the apple, pear, cherry, gooseberry, &c., in Britain, and analogous climates on the Continent), can only be considered as a luxurious waste of wealth, which would be more elegantly and usefully expended in forcing the fruits or in growing the flowers of warm climates, which can only be brought to perfection in this country under glass. Even this kind of forcing is open to criticism. For example, there are certain fruits, such as the mango, the durian, mangosteen, &c., which could only be grown in this country at an enormous expense, and probably when grown would not be worth eating; while there are certain other fruits, such as the pine apple and the banana, which can be grown in this country at a moderate expense to almost as great a degree of perfection as in their native climate. The chief benefit of growing the former would be the good that might result from it to horticultural science, by calling forth the skill and ingenuity of gardeners.

Ford (Gr. πορθμός). A shallow part of a river which can be crossed without boats or bridges. A ford is generally to be found above or below a bend, and frequently lies diagonally across the river. Cavalry can cross in four feet four inches of water, infantry in three feet three inches.

Fore. The Sea term for the part of the ship near the head.

Fore and Aft. Implies lying in the direction of the head and stern; also, the whole of the vessel generally. Fore and aft sails are the jibs, drivers, and staysails.

Fore-staff. A rude instrument, formerly used at sea for taking altitudes; and so called because in using it the observer turns his face to the object, instead of turning his back to the object, as is necessary in using the *back-staff*. Both these instruments have been superseded by the *sextant*.

Forecastle. The upper deck near the head; this was formerly much raised, hence the name. It is the part appropriated to the crew.

Foreclosure. In Law, the proceeding of a mortgagee to compel the mortgagor to elect whether to redeem the pledge or submit to the extinguishment of his right in the property, styled his *equity of redemption*. [Mortgage.] The Act 15 & 16 Vict. c. 86 now enables a court of equity in certain cases to direct a sale instead of a foreclosure.

Forefoot. A piece of timber at the fore extremity of the keel of a ship from which the stem rises. [Stem.]

Foreland. In Fortification, a piece of ground between the wall of a place and the moat. *Foreland* is also used synonymously with *promontory, cape, headland,* &c., as the North Foreland in Kent.

Forelock. On Shipboard, a small iron wedge driven through a hole in a bolt to prevent it from slipping out of position.

Foremast. The mast nearest to the bow in all vessels carrying more than one mast.

• **Forensic Medicine.** The science of medicine as applied to *forensic* questions; those, namely, which arise before courts of justice. Such are questions touching death and injury to the person; questions respecting mental capacity, disease, inheritance, legitimacy, and many more. Works of much value have been recently produced under this title, or that of *medical jurisprudence*, which is to the same purpose; see especially those of Taylor, Beck, and Guy.

Foreshortening. In Painting, the representation of any object presented obliquely to the eye. Such views or figures were called by the Greeks *catagrapha*. The first to venture upon such bold representations of the human figure in any attitude, was Cimon of Cleonæ. (Pliny xxxv. 34.)

Forest (Ital. foresta, Ger. forst, Fr. forêt: the Anglo-Saxon word *hurst*, with which the names of so many places in the south of England terminate, has probably the same origin). An extensive surface, covered naturally by trees and undergrowth; as opposed to a *plantation*, which has been made by art. In former times the greater part of every country in the temperate parts of Europe was undoubtedly covered with forest; and these by nourishing wild animals, particularly wild swine, afforded a principal part of the food of man. With civilisation, however, they gradually disappeared before the spread of extensive pastures or arable land. In every country a large portion of the forests belonged to the government, and formed a main source of its revenue. This is still the case in France and Germany, and till lately it was also the case to a certain extent in Britain.

Many of the spots which in England bear the name of *forest* have no appearance of having been covered with trees at any period since Britain became inhabited. The English forests (with the exception of the New Forest, of which the history is well known) are, however, so ancient that we possess no record of their origin. Their number has been reckoned at sixty-eight; another enumeration extends them to seventy-six, but some of these are probably only parts of the same forest with different names. A forest is created by the king, by a commission issued out of the Court of Chancery; and, when its laws and ordinances have been framed and officers appointed, it becomes a forest by matter of record. Forests are grantable to subjects; but Savernake Forest in Wiltshire, held by the marquis of Ailesbury, is, we believe, at present, the only instance. By the ancient forest laws, the Courts of the Forest were: 1. The Justice Seat; a court of justice in eyre of the forest, held every third year to take cognisance of trespasses, pleas, and causes. (The last justice seat held in England for any other than mere formal business was for Windsor Forest in 1632.) 2. The Swain-mote, or meeting of freeholders of the forests, held to receive and try presentments against offences in matters

connected with the forest laws (in *vert* and *venison*); which presentments, 3. The Woodmote was held every forty days to receive and enquire into, but not to try. These courts, once exercising much power, have fallen into desuetude with the forest laws which they administered. The principal officers of the forest were, its two justices in eyre, warden, regarders, foresters, rangers, &c.; some of which are still retained. The forest laws are of early date in England; those of King Canute are the earliest preserved. Under the first reigns after the Conquest their severity went on gradually increasing, and formed one of the chief oppressions under which the English suffered. But in 1224 the Carta de Foresta, granted by Henry III., fixed the limit of these aggressions. The capital punishments and mutilations of the former laws were rendered commutable for fines, and the king assented to a new perambulation of the forests: at which time, and subsequently, portions which had been illegally annexed to forests were disafforested. These portions are called *purlieus*. In 1297, this charter was fully confirmed by Edward I. For an account of the existing forests of this country, see *Statistics of the British Empire*.

Forest Marble. One of the members of the upper division of the Lower Oolites of England. It overlies the Bradford Clay, and contains about twenty-five feet of a workable bed of stone forming a kind of impure shelly marble often used in the internal work of our cathedrals. It is entirely made up of organic remains, but is a local deposit, being replaced at a short distance by sandstones and shales. In the north of England these are carbonaceous. In Normandy there is a coralline limestone, called *calcaire à polypiers*, which is of the same geological age.

Forests, Submarine. The inroads of the sea have in many places submerged forests of considerable extent. A submarine forest on the coast of Lincolnshire was described in 1799 by Correa de Serra. (*Phil. Trans.*) Another was discovered in 1832 in Cardigan Bay; it is said to have been submerged in the year 520. The remains of the trees are covered by peat. A similar fir wood, beneath the mean level of the sea, exists at Bournemouth, in Hampshire. These forests are sometimes also found in inland situations, of which there is a good example about four miles west of Newcastle-on-Tyne, near the river, consisting of an immense number of trees lying a few feet beneath the surface. At the bottom of the moss of Kincardine, under a bed of peat from eight to twelve feet thick, are a number of trees which have been cut down, and hatchets are occasionally found in the moss. It is supposed that these are the relics of the Caledonian forests cut down by Agricola. (Lyell's *Geology*; Thomson's *Geology*, &c.)

Forestalling the Market. In Law, is defined to be the buying up or bargaining for goods on their way to the market, in order to dispose of them at a higher price. Forestallers are usually classed with *engrossers* (those who bring up commodities to retail), and *regrators* (said to be derived from Fr. regratter, *to scrape over again*, from frauds practised in the dressing or scraping of second-hand cloth to sell again). Severe statutes have been passed at different times, from 5 & 6 Edw. V. downwards, against this alleged offence. They were all repealed by 12 Geo. III. c. 71. But it is said that the offence at common law still subsists: nor was it until 1827 (7 & 8 Geo. IV. c. 38) that constables were expressly relieved from the (obsolete) duty of making presentments of forestallers at the quarter sessions. Although acts of this description have ceased to be subjects of criminal prosecution, it cannot be said that the public prejudice against them is yet worn out; although it is easily understood, and has been often proved, that in no way can the market for most commodities be rendered steady, the purchaser protected from the injurious consequences of excessive dearness, and the seller from those of glut and over-cheapness, so well as by the intervention of an intermediate body of wholesale dealers between the former and the latter.

Forfeiture (Low Lat. forisfactura, *expulsion* or *outlawry*). In Law, a punishment annexed to some illegal act or negligence in the owner of real property, whereby he loses all his interest therein, and it goes to the party injured as a recompense for the wrong which either he alone or the public with him hath sustained. Forfeiture is either civil or criminal. Civil forfeiture takes place when some alienation is made contrary to law, as in mortmain; or when a particular tenant alienes for a larger estate than he himself hath, as when tenant for life makes a conveyance in fee. Forfeiture for criminal causes takes place in treason or felony, and for one or two other offences. After judgment has been given, and the guilty party is said to be attainted, the forfeiture has a retrospective operation to the time when the offence was committed, so as to invalidate all sales and incumbrances that may have been effected since that time. Except in treason or murder, the forfeiture is only for the life of the offender; in treason and murder, however, the forfeiture extends to the disinherison of the heir.

Forficula (Lat. forfex, *pincers*). A Linnæan genus of insects, now forming a distinct order, Dermaptera [which see]; and comprehending the subgenera *Labidura*, *Labia*, *Chelidura*, and *Forficula* proper, of which the labours of modern entomologists have made known numerous species; the common ear-wig (*Forficula auricularia*) is the type of this group of insects.

Forge (Fr.). The workshop in which iron is hammered and shaped by the aid of heat. The term is generally applied to the places in which these operations are carried on upon a comparatively small scale; the great workshops in which iron is made malleable for general purposes being called *shingling mills*. A common forge consists of the hearth or fire-

place, which is merely a cavity in masonry or brickwork well lined with fire-clay or brick, upon which the ignited fuel is placed, and upon the back or side of which a blast of air is driven in through the nozzle of a double-blasted bellows, which in a common forge is generally worked by a hand lever. Forges are sometimes constructed so as to be portable, the bellows being placed under the hearth.

Forgery. In Law, the fraudulent making or alteration of any record, deed, writing, instrument, register, stamp, &c., to the prejudice of another man's right. The statutes respecting this offence were consolidated by the Act of 1830 (11 Geo. IV. & 1 Wm. IV. c. 66), which also, after long and reiterated discussions, finally abolished the punishment of death in all cases, except for the forgery of wills and bills of exchange. This last remnant of the ancient code was finally removed in 1832 and 1837. The offence is now punishable by transportation, for which, under fourteen years, PENAL SERVITUDE [which see] has been substituted by various statutes.

According to a return contained in the report of the Constabulary Force Commission, 1839, the number of persons convicted of forging and uttering forged notes amounted to 104 in 1816, whence it increased to 352 in 1820, fell to 134 in 1821, and since that time has diminished to a very small amount. The number of executions in 1812 was 23, in 1818 (the greatest) 24. The last execution for forgery took place in 1829.

Forisfamiliation (Lat. foris, and familia). In Law, this term is used to signify that a child on receiving a portion from his father, or otherwise, renounces his title to any further share of his father's property.

Forlorn Hope. In Military language, the storming party which leads the assault upon a breach. The great danger of this service has given rise to the name.

Form (Lat. forma). In the Fine Arts, the bounding line of a material object. In Painting, the word is more generally applied to the human form. [BEAUTY.]

FORM. In Printing, the pages of type imposed and locked up in a chase ready for the press is so called.

Formation (Lat. formatio, *a shaping*). In Geology, a technical term used in speaking of certain large groups of rocks, whether stratified or unstratified. Thus it is usual to speak of a limestone, a sandstone, or a clay formation, or a granite or slate formation, without reference to limestones or other rocks of any particular age. So also we speak of tertiary and secondary formations, and formerly of primary, now palæozoic formations—the term then referring to a natural group, definite in respect to age, but indefinite as to material.

Formation Level. A term of Civil Engineering, used to denote the upper surface of the earthwork of a road, railway, or the bottom of a canal, intended to receive the metal, ballast, or puddling of the finished work. This formation level ought to be of the most unyielding character, especially in canal work.

Formedon. In Law, a writ in the nature of a writ of right, which lies for him who has right to lands or tenements by virtue of an entail. [FEE TAIL.] Formedon is in the *descender*, the *remainder*, or the *reverter*, according to the estate of the party who sues.

Formic Acid (Lat. formica, *an ant*). A sour liquor which ants eject when irritated, and which was formerly obtained by bruising the insects in water, and distilling the mixture: a peculiar volatile acid passed over. It has been ascertained by Dobereiner, that an analogous acid may be artificially obtained by distilling, from a capacious retort, a mixture of two parts of tartaric acid, three of peroxide of manganese, and three of sulphuric acid diluted with five of water. The tartaric acid acquires oxygen from the oxide of manganese, and is resolved into water, carbonic acid, and formic acid. From the analysis by Berzelius of formiate of lead, it appears that formic acid is a compound of two atoms of carbon, three of oxygen, and one of hydrogen: or of two atoms of carbonic oxide and one of water. Formic acid has also been obtained by distilling a mixture of oxalic acid and glycerine. Monohydrated formic acid is an acrid fuming liquid, easily converted by oxidation into carbonic acid and water. It may be represented as the teroxide of formyl, $= C_2H, + O_3$.

Formica (Lat.; Gr. μύρμηξ, *an ant*). A Linnæan genus of insects, now the type of a very numerous and extensively distributed family, *Formicidæ*, belonging to the order *Hymenoptera*, and to that section which is negatively characterised by not being armed with a sting, and by not possessing any instrument for piercing the bodies of animals or the substance of plants for the purpose of oviposition. Many accounts of the social economy of the ant have excited wonder and astonishment, and have been copied into most popular works: but of these alleged facts a very few only have been ascertained, while most of them seem to be the result of assumption or theory.

Formication (Lat. formicatio). The creeping sensation upon the skin, resembling the crawling of ants over different parts of the body.

Formula (Lat. dim. of forma). In Algebra, the expression of a quantity in algebraical symbols. Thus

$$\sqrt{s(s-a)(s-b)(s-c)}$$

is the formula for the area of a triangle whose sides are a, b, and c, and semi-perimeter s. Every formula may be regarded as an abbreviated rule for the solution of a problem, or as an abbreviated enunciation of a theorem.

FORMULA. In Chemistry, a concise mode of exhibiting by symbols the results of chemical changes, dependent upon the theory of atomic equivalents. These formulæ are employed either to represent the actual results of experiment, or to indicate the different theoretical or hypothetical views which may be taken in reference to the composition of

certain products. Formulæ, therefore, are either empirical or rational. As an instance of the first-mentioned application of formulæ, we may give those of water, of sugar, of carbonic acid, of alcohol, and of ether. Water is a compound of an atom of hydrogen = 1, and an atom of oxygen = 8; the formula, therefore, of *water* is H O. The formula of grape-sugar is $C_{12}H_{12}O_{12}$; that is, it consists of 12 atoms of carbon, 12 of hydrogen, and 12 of oxygen. Carbonic acid consists of 1 atom of carbon = 6, and 2 atoms of oxygen = 16; its formula, therefore, is $C\ O_2$. Alcohol is a compound of 4 atoms of carbon, 6 of hydrogen, and 2 of oxygen, its formula being $C_4H_6O_2$; and lastly, ether is a compound of 4 atoms of carbon, 5 of hydrogen, and 1 of oxygen, and is represented by the formula C_4H_5O. All these are *empirical formulæ*; that is, simple statements of the composition of the several bodies.

In the act of fermentation, sugar is resolved into alcohol and carbonic acid, and this change may be concisely represented by the following arrangement of formulæ:—

$$C_{12}H_{12}O_{12} = 4\ (C\ O_2) + 2\ (C_4H_6O_2);$$

that is, 1 atom or *equivalent* (for these terms are used synonymously) of grape-sugar is equal to 4 atoms of carbonic acid and 2 atoms of alcohol.

Now, in reference to the use of *rational* formulæ, it may be remarked, that sugar may be hypothetically represented as a compound of 12 atoms of carbon and 12 of *water*; and in that case its formula would be $C_{12} + 12\ (H\ O)$.

Again, alcohol is resolvable into ether and water; for $C_4H_6O_2$ is $= C_4H_5O + H\ O$: and lastly, ether may be regarded as an oxide of a hydrocarbon (composed of 4 atoms of carbon and 5 of hydrogen) which has been termed *ethyl*; in which case its formula might be written $C_4\ H_5 + O$; or ether may contain a hydrocarbon composed of 4 atoms of carbon and 4 of hydrogen in combination with an atom of water; in which case its rational formula would be $C_4H_4 + H\ O$.

Formyle. The basic hydrocarbon of the formic acid = $C_2\ H$.

Fornix (Lat. *an arch*). In Anatomy, this term is applied to a part of the corpus callosum of the brain, which when viewed in a particular direction somewhat resembles the shape of a Gothic arch. It is the medullary body, composed of two anterior and two posterior *crura*, situated at the bottom inside the lateral ventricle, over the third ventricle, and below the *septum lucidum*. [BRAIN.]

Forsterite. A mineral named after Mr. Forster; it forms brilliant and small crystals, colourless and translucent, and is found at Vesuvius, accompanied by pyroxene. It contains silica and magnesia, but has not been carefully analysed.

Fort (Lat. fortis, *strong*). A small enclosed fortification, field or permanent; in the former case distinguished from a *redoubt* by having its ditches flanked by its parapets. Forts are employed for occupying isolated positions, forming systems of *detached works*, and strengthening weak fortresses.

Forte (Ital.). In Music, a direction to the performer to execute loudly the part to which the word is affixed. It is indicated by the single letter F. If two F F's thus are used, the part is to be played or performed *fortissimo*, very loud.

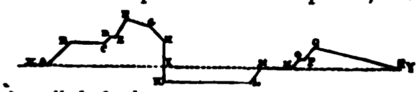
Fortification. The art of constructing such defences as may enable a comparatively small number of men to maintain possession of a military position against the assaults of a superior force; by turning natural obstacles to advantage, or by making entirely new and artificial defensive works. Fortification is generally classed under two heads, viz. *Permanent Fortification* and *Field Fortification*.

Permanent Fortification is so called from the works being required to remain effective for any length of time, for such purposes as the protection of dockyards, arsenals, depôts, important cities and positions, frontiers of states, &c.

The nature of constructions for defence will be determined by the means of aggression. In early ages, when the sling and the bow formed the principal weapons of offence, men considered themselves sufficiently defended by a single wall or a bank of earth, from behind which they could discharge their missiles against their assailants. In course of time projecting towers were added, which served the double purpose of increasing the front of the besieged, and of enabling them to attack the besiegers in flank when approaching to scale the wall. The invention of the battering ram rendered no other change necessary than that of increasing the strength of the wall. To aid the means of defence, projecting galleries were constructed at the summit of the wall and round the towers, through the pierced floors of which stones and other missiles were showered down on the heads of the assailants. These galleries were called *machicoulis* or *massecoulis*, from the French *couler des masses*. Apertures or loopholes for the discharge of arrows and javelins were made in the battlements or pierced in the walls; and the defensive means were completed by surrounding the whole place with a deep moat or ditch. But the invention of gunpowder rendered it necessary to adopt an entirely different system of defence. Walls of masonry, however thick, can only for a short time withstand the assault of heavy artillery; hence those successive circumvallations and constructions which constitute the defences of a modern fortress.

Fortifications which differ in details and principles are distinguished by the appellation of *systems*. In order to explain their structure, it will be convenient to consider them first without reference to their *plan*, or the position of the ground lines in respect of each other, but merely as defences against an army with artillery advancing directly in front. The following figure represents a vertical section of a regular fortification on the ground line X Y the

place to be defended being supposed to be to the left or rear of the point A. The mass of earth A B C D E F G H forms the rampart with its parapet. A B is the *interior slope* of the rampart; B C is the *terre-plein* of the rampart, having a breadth of about forty feet, on which the troops and cannon are placed; D E

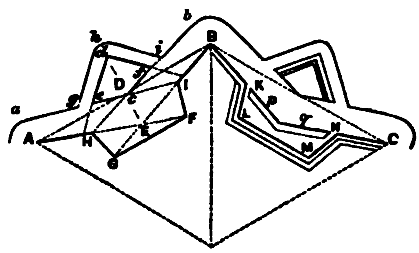


is called the *banquette*, or step, on which the soldiers mount to fire over the parapet; E F G is the *parapet*, of a height (about eight feet) sufficient to protect the men and guns on the terre-plein, and sloped in the direction F G towards M, the opposite edge of the ditch, so that a man approaching there may be seen and fired at; G H is the *exterior slope* of the parapet, and F G the *superior slope*; H K is the *revetment* or wall of masonry supporting the rampart, and strengthened by buttresses placed at small intervals behind it. This must be of sufficient height to prevent its being easily scaled; but yet must not rise higher than the edge of the exterior work at Q, in order that it may not be seen and breached by distant batteries. The exterior of the wall in front of the rampart, H K, is called the *escarp*; the wall forming the escarp need not, however, be attached to the rampart as a retaining wall, but may be detached from and in front of the rampart. I K L M is the ditch, the dimensions of which will depend upon the nature of the ground; the height of the *crest* (or top) of the parapet over the bottom of the ditch and over the top of the counterscarp (i. e. face of the ditch opposite to the escarp); the *extent* of the flanking fire; and upon the general consideration that the excavation or *déblai* must produce sufficient earth, or *remblai*, to form the ramparts and parapets. If the ditch be a dry one, the counterscarp L M must be revetted for at least fourteen feet in height, to prevent the enemy jumping into the ditch; but if it be a wet ditch, the counterscarp and escarp too may consist of earthen slopes. M N is the *covered way*, a space about eleven yards in breadth, having a *banquette* N O P, and protected by a parapet P Q, the superior slope of which, Q R, is called the *glacis*. The use of the covered way is to allow troops to be drawn up, unseen by the besiegers, for the purpose of making sorties; it also enables the garrison to keep up a closer fire on the approaches of the enemy, and its parapet forms a strong protection to the revetment of the rampart.

If between the main rampart, or *body of the place*, and its *covered way*, other works are placed, each work being of a less height than and being seen into or *commanded* by those in rear of it, it is evident that the place will admit of a more stubborn and protracted defence: the usual works of this nature, which occur in the bastioned systems, will be described farther on; those outside of the *main ditch* are called *outworks*.

The bastioned system of fortification was invented by the Italians, and by them applied during the fifteenth and sixteenth centuries; but it was reserved for the genius of Vauban, during the seventeenth and beginning of the eighteenth centuries, so to improve upon and add to the bastioned systems as they were constructed before his time, that it is now usual to consider his systems as the basis of all modern bastioned fortifications. The numerous fortifications designed or altered by Vauban have been grouped under three classes or *systems*, the characteristics and average construction of which will now be described. These systems may be considered as only differing in points of detail, or in a greater or less degree of complication.

Before proceeding to construct a fortification, it is necessary to lay down a *plan*. This will differ in some respects according to the system adopted; but the following description, which properly belongs to Vauban's first system, will explain the general method: When the work is regular, the sides are all equal, and therefore the general form will be that of a polygon inscribed in a circle. The first thing to be done is to determine the number of sides. We shall suppose them to be six. Let A B, B C be



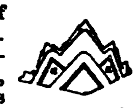
two sides of a regular hexagon, each equal to 360 yards. Bisect A B in D; draw the perpendicular D E, on which set off D E, equal to one-sixth of A B; draw the lines A E F and B E G, in which take A H and B I, each equal to two-sevenths of A B; make H F and I G each equal to the distance H I; then A H G F I B is the principal outline of one front; and by making the same construction on each of the sides of the hexagon, we obtain the outline of the *enceinte* or principal enclosing works.

The part F I B K L is called the *bastion*; B I and B K are the *faces* of the bastion; I F and K L are its *flanks*; F L is the *gorge*; G F is the *curtain*; A F and B G are the *lines of defence*; B is the *flanked angle*; I and K are the *angles of the shoulder*; G, F, L, and M the *angles of the flank*. From the points A and B as centres, and a radius of about forty yards, describe circular arcs; if lines be drawn from the opposite angles of the shoulder H I to touch those arcs, the parts of those lines *a c*, *b c*, together with the arcs, will represent the *counterscarp* of the ditch. The curtain is covered by the *ravelin*, which is thus traced: its *salient angle d*, or the intersection of its

faces, is placed at the point where the perpendicular D E is cut by an arc of a circle with the *angle of the flank*, G or F, as a centre, and the distance to the opposite *shoulder of the bastion*, I or H, as a radius; the *faces d e* and *d f* are directed to points on the *faces of the bastions*, eleven yards from the shoulders towards the salients A and B; *c e* and *c f* are the *demi-gorges*; the counterscarp *g h i* is traced at twenty-four yards from the faces and parallel to them except where rounded off at the salient.

Stairs, called *pas-de-souris*, are constructed to facilitate the descent from the ravelin to the ditch. Besides the ravelin, there is usually another appendage to the bastion and curtain. This is the *tenaille*, represented in the figure by the parts *p q* made in the direction of the lines of defence; but it has sometimes other forms. The tenaille is made in the ditch before the curtain, with passages between the ends and the flanks of the bastion. It is a low work, having its parapet only about three feet higher than the level ground of the ravelin, and its use is to protect the curtain and flanks from being breached; it also brings a lower and more effective fire on the main ditch than can be obtained from the *body of the place*; it has, however, the defect of preventing the use of *casemated* or vaulted batteries to flank the main ditch, and by masking the fire of the flanks on part of the ditch it leaves some undefended spaces in it. Vauban having invented *ricochet* fire (i.e. a fire with small charges and high elevation, sending the projectiles hopping along the length of the work to be silenced), placed traverses or *masks* of earth in the covered way to lessen the effects of this terrible invention, which revolutionised the old modes of attack.

Such are the works which form the envelope of the place fortified; but various other constructions are in most cases added, according to the nature of the ground and other circumstances, for the purpose of protecting or strengthening such parts as are most exposed, or of interrupting the works of the besiegers. These additional constructions are either internal or external. Among the former are *retrenchments* of various kinds, either constructed at the same time with the principal works or thrown up during the siege. They are made behind the ramparts, or the bastions most exposed to attack, their use being to enable the garrison to continue the defence from behind a fresh obstacle when a rampart or bastion has been breached. When a hill or rising ground overlooks any of the works, a *cavalier* is raised, about ten or twelve feet higher than the rest of the works. This is commonly placed within the bastion when it has the same form, but sometimes on the middle of the curtain when its form is semicircular. Of the exterior works, one of the most important is the *counterguard*, or *couvreface*, constructed to cover some of the principal parts, as the bastion or the ravelin, in such a manner that without obstructing their fire it prevents them from being breached till the counterguard itself is taken. The counterguard is constructed parallel with the faces of the work which it is to cover; and it must be lower than the principal work, though of a sufficient height to screen its revetment; it should not be constructed wide enough to allow the enemy to establish batteries upon it. It has many serious defects, and adds greatly to the expense of construction. A *horn-work*, represented in the annexed figure, is composed of two branches, and a front composed of two half bastions and a curtain (thus supplying its own flank defence in front) resembling a front of the body of the place; its long sides extending towards the main works are flanked by the musketry of the covered way. It is here represented as made before the curtain, but it may be also constructed before a bastion. A *crown-work* is of the same nature as a horn-work, but larger, and having two fronts, which give it somewhat the appearance of a crown. Horn-works and crown-works are constructed to occupy ground lying beyond the fortification which might be advantageous to an enemy; to strengthen the weaker parts of the main works; or to defend ground, otherwise unseen. *Demi-tenaillons a a* are sometimes added to small ravelins, and are constructed on lines bisecting the faces of the ravelin at right angles. *Tenaillons* are similar in construction to demi-tenaillons, but having one of their faces formed on lines which are the production of the faces of the ravelin, instead of bisecting those faces. The application of all these and other works of a similar description depends on the nature of the localities.



We have already noticed the use and importance of the covered way. In order to increase its strength, *traverses*, or portions of parapet, are thrown across it, which screen it from an enfilading fire, and enable the defenders to dispute its possession foot by foot. *Places of arms*, or places for assembling troops, and protected by traverses and *redoubts*, are also formed on it at the re-entering and salient angles of the counterscarp. The redoubts serve not only as a place of retreat, but facilitate the making of sorties upon the enemy's lodgements.

The descriptions given above belong more especially to that method of fortification which, in the military schools, is denominated *Vauban's first system*. In his second system, represented in the annexed figure, he separated the bastions from the body of the place by a ditch about forty feet wide, in order that the besieger, after the breach and capture of the bastions, might be compelled to renew his operations against the *enceinte* or body of the place. The angles of the polygon are crowned by pentagonal towers of masonry, called *tower bastions*, with casemated flanks, to which, in

fact, the regular bastions only form counterguards. It was from a desire to take advantage of these tower bastions, which he found already existing at Landau when called upon to fortify that place, that he was led to adopt the system in question. Vauban's third system does not differ in any material respect from the second.

He increased the size of the ravelin, and gave it a redoubt. The tower bastions were likewise made larger, and the curtain which united them was broken inwards, so as to form two small flanks underneath; while casemates for cannon were constructed, to cooperate with those of the tower bastions in the defence of the ditch. In Vauban's first system the ravelin is much too small, the defects of which are: (1) that the besieger can establish himself along the glacis close to the covered way in front of the bastion, as well as along the glacis of the ravelin, and so needs not to capture the ravelin at all; and (2) that the shoulders of the bastion are not sufficiently covered by the ravelin. In the later systems these defects were remedied by advancing the salient of the ravelin about thirty or forty yards, and directing the faces on points thirty-two yards instead of eleven yards from the shoulder of the bastion. The addition of the redoubt in the ravelin tends also to prolong the defence.

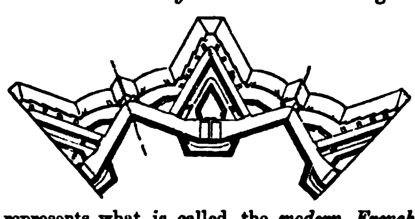
Coehorn's System.—Contemporary with Vauban was the baron de Coehorn, director-general of the fortifications of the United Provinces of Holland. His methods are only applicable in low swampy countries, like Holland. By covering and flanking his works more effectually than had previously been done; by depriving the assailant of the room necessary for erecting his batteries; by making the ditches in front of the exterior envelopes wet, but those in rear of them, and between them and the main works, dry; thus providing a safe retreat for the defenders, and enabling them to form up conveniently to resist the enemy after he had crossed the wet ditches; and by keeping those parts of the works in which the besieger would have to make his lodgements, at such a level that he would come to water after digging a few inches deep, Coehorn endeavoured to apply the principles of the Italian bastioned system to the peculiar positions of his native land: extending and modifying these principles with great talent and success. An idea of his methods may be formed from the annexed figure, which represents his first system.

It will be perceived that there is an inner and an outer bastion and ravelin. The main ditch is swept by three flanks, the two lower ones being protected from all but direct fire by the *orillons*, which are casemated buildings placed at the shoulders of the bastions. The ditches are wider and shallower than in previous systems. Coehorn added redoubts *a a* in the covered way in the re-entering places of arms. Coehorn's principles have been adopted in the construction of the fortresses of Nimeguen, Breda, Manheim, Namur, and Bergen-op-Zoom.

Cormontaigne's System.—The methods of Vauban were improved in many essential respects by Cormontaigne, a French officer of engineers, who died in 1750.

In the system which he adopted, and which is here represented, the faces of the bastion are made longer than in Vauban's methods, and the flanks are placed at right angles with the faces of the opposite bastions. The enlargement of the bastion renders it capable of containing interior retrenchments; and the flanks, though shortened, are better covered. His ravelins are also constructed on a larger base, and contain a larger redoubt, from which the besiegers can keep up a reverse fire on breaches made in the collateral bastions; so that the assault upon the latter becomes impracticable until the ravelin and its redoubt are both captured. The communications round the extremities of the traverses of the covered way are arranged in a zigzag line; so that the passage round the extremity of one traverse is defended by the fire of another in its rear, and the advance of the assailants along the covered way thereby checked. Cormontaigne effected decided improvements by introducing redoubts into the covered way, thus giving a safe retreat to its defenders; and by giving flanks to the redoubt of the ravelin, but not to the ravelin itself, the faces of which, extending straight down to the main ditch, are better able to cover the shoulders of the bastions than those in Vauban's systems. One great defect in this system is that the ditch of the redoubt of the ravelin is not flanked properly from the enceinte.

Modern French System.—The annexed figure



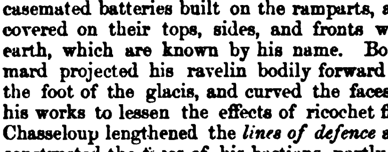
represents what is called the *modern French system*: it varies but little from that of Cormontaigne. The ravelin is made to cover the shoulder of the bastion more effectually by a greater projection and wider base, and its faces are retrenched by *coupures* or cuts through the rampart, perpendicular to the faces of the bastion, which prevent the enemy from taking the redoubt in the re-entering place of arms without first possessing himself of the redoubt in the ravelin. The ditch of the redoubt of the ravelin receives flank defence from the faces of the bastion. Great attention has wisely been bestowed to make the communications for the defenders, between the different parts, safe and easy; that across the main ditch from the redoubt of the ravelin to the tenaille is covered

by a *double caponier*, i. e. a parapet of earth on each side sloped off at the top like a glacis. The face of the bastion is protected from being breached through the ditch of the ravelin, by a traverse or mask of earth.

Among modern writers and engineers, Carnot advocates a detached escarp wall loopholed; a flat slope of earth, to allow the defenders to make sorties readily, in lieu of the ordinary counterscarp; a much more liberal use of vertical fire from mortars; and the adoption of bombproof casemated batteries. Dufour, directing his attention chiefly to preventing the outworks from being *enfiladed* by *ricochet fire*, raised the salients into *cavaliers* and *bonnettes*, to intercept this fire. Choumara suggested widening the ditch, and placing in it an interior *glacis* high enough to cover the escarp and sloped off to the foot of the counterscarp; and the formation of high traverses against ricochet fire at various parts, some of them being converted into cavalier batteries. Haxo as well as Choumara advocated the principle that the trace of the parapets need not be parallel to that of the ditches, whereby the parapets may be traced so as to fire with the best effect, and the ditches so as to be most convenient and least exposed: he invented casemated batteries built on the ramparts, and covered on their tops, sides, and fronts with earth, which are known by his name. Bousmard projected his ravelin bodily forward to the foot of the glacis, and curved the faces of his works to lessen the effects of ricochet fire. Chasseloup lengthened the *lines of defence* and constructed the faces of his bastions partly on the *exterior side of the polygon*. Noizet suggested the modifications and improvements contained in the *modern French system*.

All the systems above enumerated, however much they may differ in details, agree in their principal features, and present the same general outline. They may be all included under the name of the *bastion system*.

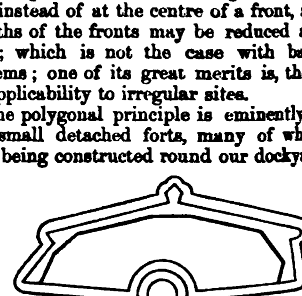
Polygonal or German System.—While the French in modern times have chiefly applied themselves to improving the bastion trace, the Germans, acting on the suggestions of Montalembert (to suppress the flanks and curtain, and allow the faces of the bastions to be produced inwards till they met), have heartily embraced the principle of what is termed the *polygonal system*—the enceinte being constructed either actually on the lines of the surrounding polygon or close to them; and both in theory and practice, they have carried it to great appa-



rent perfection. But as no fortress constructed on this system has stood the test of a siege, its advantages and defects are as yet only theoretical. The following is a description of one of the varieties of the polygonal system. The main ditch is flanked from the centre of each front by a *caponier* C, or arrangement of casemates in one or two tiers; as the guns in these would fire grape and case shot, the length of the *lines of defence* C A, C B, or distance from the caponier to the salients, may be about 300 yards; therefore the average length of the front or side of the polygon will be 600 yards. The front is slightly indented, to allow of the salient of the caponier being flanked from casemates in the indents H H. If the great central caponiers are built for two tiers of guns, it is plain that they can oppose two guns (or even three if the flat roof is armed) to every one the besieger can place in counter battery; and if this caponier be protected from serious injury from distant fire, it is evident that it will present an obstacle of the most formidable nature at the most critical period of a siege. To diminish as far as possible the space upon which the besieger would construct these counter batteries, the ditches at the salients are only twenty to twenty-five yards wide, gradually increasing in width towards the caponier, the counterscarp being traced to the ends of its sides, which are forty yards in front of the exterior side. Ten yards in front of the caponier is a casemated redoubt D, and ten yards in front of this is the ravelin E, which projects until its salient is 60°, i. e. as far as possible compatible with strength. The ditch of the ravelin is flanked by redoubts F F, which have earth raised on their tops to screen the enceinte from fire down this ditch.

The *re-entering places of arms* have casemated redoubts G G in them. The caponiers may be placed at alternate angles of the polygon instead of at the centre of a front, and the lengths of the fronts may be reduced at pleasure; which is not the case with bastioned systems; one of its great merits is, therefore, its applicability to irregular sites.

The polygonal principle is eminently suited for small detached forts, many of which are now being constructed round our dockyards.



Attack of Fortresses.—Since the introduction of enfilade ricochet fire, the reduction of a bastioned fortress has proved such a certainty, when the attack is adequately and properly conducted, that the number of days required may be calculated beforehand with tolerable accuracy. The besieger having *invested* or surrounded the fortress, and cut off all means of ingress or egress, makes his *reconnaissance* or critical examination of the position: having selected the most favourable point of attack, he prepares his project of attack; he then makes

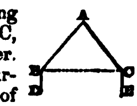
his *first parallel* or trench, in which his *guards of the trenches* are placed to protect the men in the batteries, which are next constructed. The object of these is to reduce the fire of the place sufficiently to allow of the approaches being pushed forward in zigzags which afford secure communication to the front; other parallels are then constructed; and so on until the covered way is reached, the outworks breached and captured, and upon them batteries are constructed to breach the enceinte and silence its flanking fire; the assault is then made or the garrison capitulates. In the attack of a polygonal fortress, it remains to be proved whether or not the besieger will be able sufficiently to silence the reserved flanking fire of the main ditch, to be enabled to cross it. It also remains to be seen what will be the effect of rifled guns on the attack and defence: there can be little doubt that the first batteries and parallels must be commenced farther from the fortress, and that consequently the duration of the siege will be extended.

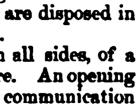
Defence of Fortresses.—An active defender will greatly delay and interrupt the siege operations of the besieger, by artillery fire and by sorties at night; and he will take timely heed to retrench those parts of the enceinte liable to be breached; but besides these and other obvious operations, he will place his guns as far as possible behind iron embrasures, and under bombproof covers, composed of timber supporting five or six feet of earth, called *blinded batteries*. No fortress can be said to be perfect in its defensive arrangements which has not a well-devised system of *countermines*, placed under its most advanced glacis for a distance to the front of sixty or seventy yards; the galleries or vaulted underground passages (by means of which positions for the charges are reached) are placed near enough together—about twenty-five yards—to prevent the besieger passing between them without being heard; but this interval most probably will have to be reduced, as boring machines are being introduced instead of picks and shovels.

Although it is considered that the besieger, having unlimited resources at command, and being able to restore his damaged galleries, which the defender cannot, must eventually win in this subterranean warfare; still the delay to the besieger of nearly a month might be of the greatest importance in its effect on the campaign, and might lead to the relief of the fortress.

Field Fortification. — Field fortification is the art of constructing all kinds of temporary works for assisting the operations of an army in the field, and enabling it to maintain a position against a superior force. In the disposition and construction of such works, the engineer must have regard to the nature of the locality, and endeavour to turn to the best account all its natural advantages, as well as the buildings, enclosures, &c., which may be found on it; and there is no part of his art in which talent and skill are so requisite, or in which he must rely so exclusively on the resources of his own judgment. On account of the endless varieties and accidents of the ground on which he has to act, the observance of fixed rules is, indeed, impracticable: nevertheless, there are certain general maxims which apply to the construction of fortifications of all kinds, whether temporary or permanent, and which must be observed in all his operations. For example, works constructed to flank others must not be at so great a distance as to be beyond the effective range of musketry: the angles of defence should be nearly right angles, and the salient angles as obtuse as possible. The general nature of defensive works is also the same in all cases, namely, a ditch and a parapet; though, as the pickaxe and the spade are the only implements which an army in the field can carry about with it, the depth and width of the ditch and the height of the parapet are in field works necessarily limited to what can be effected by these simple means.

Field works are usually divided into three classes: 1. Works open at the gorge; 2. Works enclosed all round; and 3. Lines either continued or with intervals. To the first class belong *redans*, single and double, and *lunettes*; to the second, *redoubts*, *star forts*, and *bastioned forts*; and to the third, lines of various kinds for defending a position. The *redan* is the simplest of all works, consisting merely of two lines, A B and A C, forming an angle with each other. It is only employed for such purposes as defending the avenues of a village, bridge, or defile. The length given to it is usually about fifty yards. When the redan is thrown out in front of other works, it is called a *flèche*, or arrow. Lunettes are also applied for similar purposes, and are formed by adding two parallel faces, B D and C E, to the redan, at the extremities of its open flanks. The *double redan*, or *bonnet de prêtre*, consists of two faces, A B and C D; and two flanks, A E and C E, usually shorter than the faces, and affording a reciprocal defence to each other. The re-entering angle at E should be a right angle: if it is less, the two flanks are in danger of being struck by each other's fire; and if it is much greater than a right angle, the defence will be weakened; for it is found by experience that soldiers placed behind a screen invariably fire straight before them, or at right angles to the screen. When a greater extent of front is to be fortified, the lines are disposed in the form of bastions or tenailles.

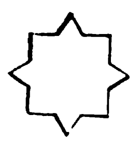




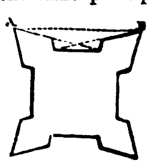
Redoubts are works closed on all sides, of a polygonal figure, usually a square. An opening is left in one of the sides, for communication with the exterior, and a traverse is thrown up within for protecting it. As the work is without flanks, the ditches are left without defence, unless supplied by two rows of stockades placed across the ditch. Stockades are formed by firmly planting stout timbers, touching each other, in the ground, and loopholing them: a

roof may be formed by placing timbers from one row to the other and covering them with earth. Counterscarp galleries may also be employed for flanking such ditches. The angles are sometimes rounded, or cut off, in order that a fire may be maintained on an assailant advancing in the direction of the diagonal.

Star forts are enclosed works constructed upon an equilateral triangle or a square. In the former case they have six points, in the latter eight. When constructed on a square, each of the sides (which may be about ninety yards long) is divided into three equal parts, and on the middle part an equilateral triangle is constructed, which gives the trace of the figure. The object of this work is to remedy the defects of the redoubt by flanking the angles of the square.



Bastioned forts are constructed in the field on the same principles as in permanent works; the distance A B, or exterior side of the polygon, should not exceed the range of musketry. They are employed only in fortifying important positions, and require accordingly to be constructed in a more solid manner than other works of a temporary nature.



The last class of field-works comprehends *lines* of various descriptions. *Continued lines* are constructed to enclose a front, or connect principal works with one another by a continued parapet. They are constructed, according to circumstances, with redans, tenailles, or bastions, placed at intervals. From the descriptions given above, the different forms of the *redan line*, *tenaille line*, and *bastion line* will be readily conceived. Sometimes they are formed of a succession of faces and flanks at right angles. In

this case they are called *indented lines*. The flanks are about a fourth of the length of the faces, and afford a defence to the ditches. Lines with intervals consist of isolated works, as redans or redoubts, placed at intervals so as to afford one another a mutual defence.

Besides the works now enumerated, various expedients are resorted to in order to prevent, or at least to render more difficult, the approaches of an enemy. Among these are *palisades*, *abatis*, *trous-de-loup*, *chevaux-de-frise*, *crows' feet*, &c.

The principal authors on Fortification besides those mentioned above are Errard, Stevinus, Antoine de Ville, De Pagan, Mallet, Belidor, Blondel, Bisset, Mouzé, &c. [IRON ARMOUR PLATE.]

Forum (Lat.). In Roman Antiquities, an open space before any buildings, especially before sepulchres. The fora of the Romans were large open squares, surrounded by temples, houses, basilicæ, or porticoes; they served as market places, as well as for public meetings of the citizens, and for the administration of justice. The forum was also, in later times, used for the shows of gladiators. There were in Rome fourteen fora for the sale of goods, provisions, and merchandise; these were thence called *fora venalia*. There were three others for civil and judicial proceedings, called *fora civilia* and *judicialia*; one of these was the Forum of Trajan, of which the column erected in memory of his victories over the Dacians was the principal ornament. [AGORA.]

Fossa (Lat. *a trench*). In Zoology, is applied to certain depressions on the external surface; generally the seat of cutaneous glands, as the *lachrymal fossa* in deer and antelopes, the *jugular fossa*, *inguinal fossa*, &c.

Fossa Ovalis. A depression in the right auricle of the heart, which in the fœtal state opened into the left auricle, forming the *foramen ovale*.

Fosse (Fr.). [DITCH.]

Fossil (Lat. fossilis, from fodio, *I dig*). Literally, anything dug out of the earth. The term is now chiefly confined to organic remains.

Fossil Farina. A soft carbonate of lime.

Fossiliferous Rocks. Rocks containing fossils or organic remains. Rocks are thus designated which have been found in any part to contain fossils, although in some places they may not exhibit them. Thus, many sandstones are in part barren of organic remains; but as such remains are found in some sandstones, the latter belong to the fossiliferous series. Mechanical rocks without any fossils are not perhaps to be found in any country. Even slates and greatly metamorphised limestones almost always contain some proof of their having originated in the vicinity of life, and hardly any sandstones not actually quartzites can be regarded as without fossils. Gneiss has lately been recognised as fossiliferous. The term is therefore better explained by negative than positive expressions. Granites, lava, basalt, and mica schist have never yet been found to show organic marks even of the faintest kind, and they are for the present therefore excluded from the list of fossiliferous rocks; everything else is included.

Fossores (Lat. *diggers*). An extensive group of Aculeate Hymenopterous insects, most of the species of which are organised for excavating cells in earth or wood, in which they bury other insects in a wounded and feeble state, and at the same time deposit their eggs; so that the larvæ, when hatched, find a store of food prepared for their sustenance. The Fossorial Hymenoptera are solitary in their habits; and some species, which have not the requisite structure of the legs for burrowing, are parasitic, and, like the cuckoo among birds, lay their eggs in the nests of other species, at whose expense the young are reared.

Fossorial. In Zoology, animals which dig their retreats and seek their food in the earth are so called. The locomotive extremities, which are organised for burrowing, as those

of the mole, or mole-cricket, are called *pedes fossorii.*

Fossulate (Lat. fossa, *a trench*). When a surface presents one or more somewhat long and narrow depressions.

Fother. A weight of lead containing eight pigs. At the mines it is equal to twenty-two and a half hundredweight, but with the plumbers in London it is nineteen and a half hundredweight.

Fougass (Fr. fougasse). In Fortification, a small mine, from six to twelve feet underground. It sometimes consists of one or more loaded shells, sometimes of a charge of powder covered with small stones.

Foul. The term applied to the wind when contrary; also to the bottom when uneven and rocky. [ANCHOR; FALL; HAWSE.]

Foundation (Lat. fundatio, though only used in Latin in an architectural sense). A term applied to such permanent institutions as were intended at the time of their creation to serve some purpose of utility or charity, or to perpetuate some real or supposed service to the community or an individual. Thus some of these institutions are devoted to the cause of education general or special, as the endowments bestowed on students, teachers, and professors in universities, where the benefaction is intended either to stimulate study, or to aid those who are imparting what they have learnt, by affording comparative leisure for the occupation which they follow. Some are of a charitable character; as, for instance, the endowment of hospitals, schools, asylums, and almshouses, where occasional distress or unavoidable poverty furnish a plea for taking the objects of charity out of the condition into which the ordinary operation of social forces in the competition for the means of life has put them. Or, again, a foundation may be created for the purpose of giving facilities for the supply of undefined but probable services, as those which are devoted to the maintenance of purely scientific investigation—for instance, an endowment to an observatory. And lastly, some may have a distinctly religious object. Thus the college of All Souls in Oxford owes its existence to a benefaction of Archbishop Chichele, who intended to supply a perpetual charity, in which prayers and similar services should be duly and regularly offered for the souls of those who had perished in the various wars with France.

The privilege of devoting a portion or the whole of one's substance to these and similar purposes has been regarded with great jealousy during the whole of the legal history of England. Grants of land for the endowment of charitable foundations are generally prohibited under the mortmain Acts, though the suspension of these Acts in favour of any particular institution is left to the discretion of the crown, and forms the sole relic of that portion of the prerogative which occupies so large a space in the constitutional history of this country, under the name of the *non obstante* clause or dispensing power.

It does not appear, however, that the motives which led to this hostility have ever been very clearly expressed, or referred to any rational principle. The preamble of the last mortmain Act assigns as a reason for its enactments the danger which may arise from the possible disherison of lawful heirs, an inconvenience which is not very obvious where there happens, as is generally the case, to be either no heir at all, or no heir sufficiently near to stimulate the supposed duty of devising one's estate to relations never heard of or never cared for.

Foundations or endowments have an economical significance, and must be governed and regulated with a view to public utility. It is manifestly only by a consideration that tantamount or greater advantages are secured to mankind by such a determination, that persons can be permitted to bind posterity in the appropriation of a particular part of the soil of any country to permanent special purposes. No right accorded to a testator, by which he can after death exercise a control over the volition of the living, can be defended on abstract principles, but only on the entirely à posteriori considerations of probable public benefit; and if it be shown that the right exercised is mischievous to society, every existing generation may justly rescind the power, and resume the impropriation. And there can be no case in which this power of ultimately revising the terms of a gift or grant for future or permanent purposes, and of annulling it if it should appear inexpedient in its effects, is more inalienable than when the gift is made in something of absolutely limited quantity and of great necessity, such as land. To maintain that grants in perpetuity for special purposes are so sacred as to be taken out of the possibility of future alteration or resumption, is to argue that the dead may always bind the living, that those who have long since quitted the business of human life may continue to control the action of those who are constrained by all considerations of duty and prudence to make the best use of the materials before them in their own generation.

There is, however, an economical defence for some endowments, even in perpetuity. In the ordinary course of society, services proffered, received, or exchanged, have an immediately intelligible value. They are produced, and their production is sustained by demand; and if individuals continually interpreting their worth, continually desire them, the supply is forthcoming sooner or later, at home or from abroad, and any indirect stimulus is not only unnecessary, but mischievous to all parties. Not so, however, in two cases: one, that in which the service is of great and demonstrable value, but where the value is only remotely or obscurely applicable to the individual; the other, where the demand is exceedingly urgent, but the capacity for securing the supply is not and could not be voluntarily, rapidly, or even ultimately possessed by the person deriving the advantage in question.

Under the first of these fall such endowments as are made for educational purposes. We all know how much economical value is added to labour when it is educated. But to wait till those who are ignorant, vicious, or dishonest wish to be taught, would be the silliest act of the laziest optimism. Of course the assertion of this principle does not involve the assertion of its details, or determine that this or that method is to be adopted in imparting the education needed; but it does imply that when the morality of society and the conscientiousness of individuals are far more advanced than at present, the supplementary aids of primary education may be abandoned. Similar reasonings apply to the higher branches of study and thought. Every moral and material improvement, every political and economical reform, has been achieved by theory at the expense of experience. It was out of the comparative leisure afforded by an endowment that Adam Smith announced those theories which, with some corrections and additions, are now recognised as equivalent to social laws, but which directly contravened experience in the first instance. It was in complete opposition to experience that Galileo developed the true solar system, and made it possible to transfer the study of the heavens from the dreams of the astrologer to the practical labours of the scientific navigator. There is certainly no department of human thought which has not been illustrated by patient speculative enquiry, and as yet nothing has aided such enquiry so much as the existence of endowed foundations.

In the second place, foundations are of the greatest importance where the demand is urgent, necessary, and natural, but the capacity to secure the supply is wanting. Such are hospitals and asylums. The services of experienced physicians and surgeons are necessarily costly, and in ordinary cases wholly beyond the means of many members of the community. The most frequent of the cases, too, in which the service is required are unforeseen, and therefore cannot be provided for, at least in any great degree. The accident which may deprive a man and his family of his bread, the sickness which may prostrate his energies, the disease which may paralyse his mind, are contingencies which fall within the calculations of a statistical average, but cannot be said to be justly or necessarily present to an individual labourer. The charity, therefore, which provides aid or refuge from these calamities, is wholesome, expedient and just, and could not be discouraged without a serious public detriment.

The same reasoning applies to endowments for the education of orphans and children whose parents are unable to support them. The inability may be the vice of the parent, but it cannot be the sin of the child. Hence, if such institutions can be preserved from abuse, and if they are found to be always necessary, society may justly, both for its own sake and for the sake of those who receive the bounty or aid, interfere to lighten undeserved and helpless suffering.

Foundations. In Architecture, the lower part of a wall, on which the weight of the insistent mass is raised, and always of a much greater thickness than such insistent wall. The practice of the ancients of laying the foundations on concrete, composed of hydraulic or other lime (as they may be required to resist the effects of water, or otherwise) mixed with coarse gravel, has been lately revived with considerable success. When concrete is well made, it is adapted to this purpose. Unfortunately in England the proper mode of using lime is so little understood, that the concrete generally employed is in fact nothing more than sand, with a small quantity of cementitious material. Sand is, however, a good foundation provided it be prevented from spreading laterally.

Founding or **Foundry.** The building in which various metals are cast into moulds or shapes. Such of the details of the processes carried on in the respective metal foundries as are consistent with the plan of this work, will be found under the heads of the metals to which they refer. The furnaces used in fusing and founding metals are variously constructed, according to the nature of the metal and the quantity to be operated upon; and frequently furnaces of different constructions are employed in the same foundry. The wind furnace, blast furnace, and reverberatory furnace, are the forms which are most generally employed. The wind furnace is either square or circular, and varies in dimensions, according to the size of the crucibles which it is intended to contain, and which are placed upon proper supports resting generally upon the bars or grating of the furnace. It has three apertures; one above, for the purpose of introducing the crucible and fuel, and which is usually closed by a fire tile or brick; another below, for the purpose of admitting the air, so as to pass through the grate and fuel, and up the chimney; and the third communicating with the chimney, which should be lofty and supplied with a damper, for the purpose of regulating the draught of air through the fireplace, and consequently also the heat produced.

The blast furnace differs from the preceding in having no grating, and in the air being supplied by a bellows or blowing machine. The construction of these furnaces is much varied, according to circumstances; but the largest and most perfect are those employed in the iron works.

The reverberatory furnace is so constructed, that the flame and hot air from the fireplace are directed into a separate cavity intermediate between it and the chimney. In this cavity, commonly called the *hearth*, the materials to be fused are placed; and there is an aperture connected with it by which the fused metal is suffered to run out, or through which it may be removed in ladles for the purpose of supplying the moulds.

The materials of which the *moulds* are

formed are very various. In some cases, as in stereotype founding, they consist of plaster of Paris; in bronze works for figures and statues, they are made of a mixture of plaster of Paris, sand, and brickdust, and require the utmost skill and care in their preparation. Iron is usually cast in sand; brass and other metals in clay; and very frequently the moulds are made of cast iron.

Foundling Hospitals. In those ancient nations with the details of whose social life we are acquainted, the practice of exposing new-born infants seems to have been, as it is at this day in China, a species of legitimate infanticide. Neither Plato nor Aristotle, nor in general any political writers of antiquity, condemn it; they merely profess to lay down rules for the preservation of the healthier and stronger, at the expense of the more weakly. Among the Greeks a more tender mother chose the market-place, or some temple for the exposure of her child, in order to have the chance of some charitable hand succouring it: if its death was desired, it was abandoned in solitary places; and their dramas and romances are full of narratives in which this custom forms the foundation of the interest. Thebes, in republican Greece, is the only state in which the exposure of children is known to have been forbidden by law. The practice of exposure was common in republican Rome: the law is doubtful. The street called Velabrum (Juvenal, *Sat.* vi.) and the column called Lactaria (from this circumstance, according to some antiquaries) were places usually selected for the purpose. Abandoned children were declared by law to be the slaves or absolute property of those by whom they were brought up; and several were saved from death, not from human motives, but that their foster-fathers might, by mutilating their persons, and exhibiting them in the streets, derive an infamous livelihood from the alms given them by the passengers. At length the progress of Christianity put an end to these disgusting enormities. The exposure of children was made a punishable offence in A. D. 374; and their slavery was abolished by an edict of Justinian in 530.

Infanticide has most properly been prosecuted with the utmost rigour, and made a capital offence in almost all modern countries. But it was early supposed that were the exposure or abandonment of children wholly prohibited, there would, despite of all that could be done to prevent it, be a great deal of infanticide. In consequence of the prevalence of this feeling, it has been customary in the Christian world, from a very remote period, to connive at the abandonment of children, and to provide means for the support of those that might be abandoned; and hence the origin of foundling hospitals.

The first distinct trace of an express foundation for foundlings is at Milan in 787. In 1070 the order of Brothers of the Holy Ghost was established with the express purpose of taking care of sick, orphans, and foundlings. After that time this species of foundations rapidly multiplied in every part of Europe. But while private beneficence was thus exerted in their behalf, the church, which in the earlier period had undertaken the general care of them, seems by degrees to have thrown on the commonalty, in most European countries, the charge of nourishing such as were not received into any of the foundations. Traces of legal contests between the religious and civil establishments on this subject are to be found in the history of France through the whole sixteenth century. The uncertain state of the law rendered their preservation in that country extremely precarious. St. Vincent de Paul, in the seventeenth century, undertook their cause; and the foundation of the great Foundling Hospital of Paris, in 1670, is due to his efforts. In the provinces, and in most Catholic countries, and in those under the Greek Church, public charity took the same direction.

It has been customary in these establishments to receive all children brought to them, without enquiring whether they were the fruit of regular marriages or of illicit amours. It seems idle to deny that the multiplication of such establishments, by providing a ready method for disposing of children, must have hindered a few cases of infanticide; but the injury they have done to public morals, and the waste of human life which they have occasioned, are ten times greater evils than any they have obviated. Well-informed persons in this and other countries have long been aware of the pernicious tendency of foundling hospitals; and it is probable that at no very distant period they will be everywhere suppressed. In France the multiplication of these hospitals, and of exposures, has at last called the attention of the public to the frightful immorality, mortality, and expense which attend it. In 1680, ten years after its foundation, the great hospital at Paris admitted 890; in 1750, 4,000; in 1830, nearly 8,000. In all France there were nourished at the public expense, in 1784, 40,000 children; in 1809, 69,000; 1826, 118,000. The number in 1848 was 98,872, and it is still decreasing. It varies greatly in the different departments; being greatest in the north, centre, and south; least in the eastern departments bordering on Germany, and in the western, or Brittany, La Vendée, &c. The statistics of France plainly show that it is 'not poverty, but luxury, which produces exposures.' (Terme and Montfalcon, *Histoire des Enfans Trouvés.*) The two great measures for reducing the burden which have lately been partially put in execution, are the suppression of the turning-boxes, or, in other words, rendering the abandonment *public*; and the removal of the new-born children into another department, which, it is said, always produces, when tried, a great reduction in the number of exposures. In Italy, Belgium, &c., similar institutions prevail, and a similar increase of burden has of late years been felt. It has, no doubt, been augmented by the improve-

ment which has taken place in the management of these unfortunate creatures. Formerly death soon relieved the institutions of their maintenance. Towards the end of the last century, 80 per cent. of the children are said to have died at Paris in a single year; 90 at Marseilles; 91 at Dublin. The mortality is now much diminished; though it is thought that in France nearly 60 per cent. still die in their first year. The whole number of children annually exposed is said to be, at St. Petersburg, about 45 per cent. of those born; Rome, 28; Lisbon, 26; Vienna, 23; Paris, 21. In England, Captain Thomas Coram is celebrated for his establishment of the Foundling Hospital in 1739. It was extremely popular at the time, and for many years was assisted by frequent votes of parliament. Similar institutions were projected in other parts of the country; but the enormous increase of abandonments, and the expense which they occasioned, produced such an alteration in public opinion, that the system of the foundling hospital was entirely altered; and, notwithstanding its name, it is now destined merely for the reception of orphans. Abandoned children in England become burdens to the parish in which they are found.

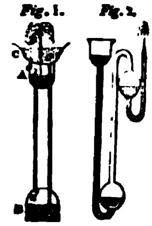
Fount or **Font** (Fr. fonds). The quantity of types of any particular sort in a printing office, whether it be great or small. Thus a small fount may consist of fifty or one hundred pounds weight, comprising the usual proportion of the various letters of the alphabet; and a large fount of thirty thousand or forty thousand pounds weight, or more. When the typefounder has not cast a proportionable number of each type, the letters required are called *imperfections*, as making the rest of the fount imperfect.

Fountain (Lat. fons). By this term is designated any natural or artificial apparatus by means of which water springs up. In natural fountains the ascensional effort is produced by the hydrostatic pressure of the water itself; in artificial fountains it is produced either by the same pressure, or by that of compressed air, or sometimes by machinery.

Natural fountains have their origin as follows: The rain which falls from the atmosphere is absorbed in three different ways. One part of it collects in rills on the surface of the ground; these unite in streams or rivulets, which flowing into one another form rivers, and thus it is conveyed to the ocean. A second part is taken up in giving humidity to the soil, from which it is returned to the atmosphere by evaporation. A third portion descends into the earth, through soils of a spongy or porous nature, or through crevices and interstices in the strata, until it meets, frequently at a very considerable depth, with strata through which it cannot penetrate, and is then collected in subterraneous reservoirs. When confined in this manner, it is subject to the pressure of the water which fills the channels through which it has descended; and when this pressure is sufficient to overcome the resistance of the superincumbent mass of earth, the water breaks through the superficial strata, and gushes forth in a spring. But if the strength of the superincumbent materials exceed the hydrostatic pressure, the water will remain stored up as it were in the subterraneous reservoir. Now if the ground above such a reservoir, or any channel communicating with it, be perforated, the water, having free access to the opening, will rise in it till it attains the level of the highest part of the channels from which it is supplied. If this level is above the surface of the ground, the water will have a tendency to rise; and when the ascensional force is considerable, it may by proper means be formed into a fountain. That subterraneous reservoirs formed in this manner exist in great abundance, and at great depths under the surface, we have sufficient evidence in the facility with which water may be obtained in almost all countries from *Artesian Wells*. [ARTESIAN WELL; HYDRODYNAMICS.]

Fountain of Hero. An ingenious hydraulic machine, of which the invention is ascribed to Hero of Alexandria, who lived about 150 years before our era. Its principle is the transmission of the pressure sustained by a body of water in one vessel to that in another by means of the elasticity of air. The essential parts of the apparatus consist of two close vessels, A and B, the first placed at some height above the other, and connected by a frame; and of three tubes or pipes, of which the first, *a b*, descends from a basin C to very near the bottom of the lower vessel B, the second, *c d*, rises from the summit of the vessel B to the top of A; the third, *e f*, rising from the lower part of A to some height above A, and forming the jet at *f*.

Fig. 1. Fig. 2.



Conceive the vessel A to be filled with water, and B with air. In this disposition of the apparatus, let water be poured into the basin C; this will descend through the pipe *a b*, and gradually fill the vessel B. But as it rises in B the air in that vessel escapes through the pipe *c d*, and is compressed at the top of A, and, by its spring or elasticity, forces the water through the tube *e f*, and thus produces a jet at *f*, which will continue until the vessel A is nearly emptied, or B nearly filled. The force which produces the jet is equal to the pressure of a column of water, the height of which is equal to the difference of the levels of the water in C and B: according to this theory, therefore, the water should spout to a height above its level in A equal to that distance; but its friction against the walls of the tube *e f*, and the resistance to its ascent offered by the air, prevent more than a fraction of this height being attained.

The second figure represents the fountain of Hero in another form. An apparatus constructed on this principle is employed for draining the water from the mines of Schemnitz in Hungary.

Fourier's Theorem. An important algebraical theorem discovered by Fourier at the commencement of the present century, though only published in 1831, after his death. Although theoretically inferior to *Sturm's Theorem*, it provides us with a convenient method of ascertaining the maximum number of real roots of an equation which lie between prescribed limits. It may be thus enunciated: The number of real roots of an equation $F(x)=0$ which lie between given limits α and β cannot exceed the difference between the variations in sign presented by the two series

$$F(\alpha), F'(\alpha), F''(\alpha), \quad . \quad . \quad . \quad F^{(n)}(\alpha);$$
$$F(\beta), F'(\beta), F''(\beta), \quad . \quad . \quad . \quad F^{(n)}(\beta).$$

The demonstration of this theorem, given in all text-books, is based upon the following two properties: 1. Whenever during its gradual increase, x passes through a root of $F(x)=0$, the series

$$F(x), F'(x), F''(x), \quad . \quad . \quad . \quad . \quad . \quad F^{(n)}(x)$$

loses as many variations of sign as there are roots equal to that root. 2. The series never gains variations of sign when the derived functions vanish, and never loses them but in even numbers. It will be observed that when $\alpha=0$ the above series reduces itself to that of the coefficients of the given equation, taken in inverse order, and when $\beta=+\infty$ the series presents no variations of sign; so that for these two limits, Fourier's theorem coincides with DESCARTES' RULE OF SIGNS.

There is another theorem in the integral calculus, due to the same eminent mathematician, which must here be mentioned, inasmuch as it is also frequently referred to as *Fourier's Theorem*. According to it, any function $f(x)$ may be expressed in the form of a double integral, thus:

$$f(x)=\frac{1}{\pi}\int_0^{\infty} d\omega \int_{-\infty}^{\infty} \cos w\,(x-v)\, f(v)\, dv;$$

a formula of the greatest importance in pure and applied mathematics. For its demonstration, as well as its exact signification, we must refer the reader to De Morgan's *Differential and Integral Calculus*; to a very able paper by Prof. Boole in the *Transactions of the Royal Irish Academy*, vol. xxi.; or to Fourier's *Théorie de la Chaleur*, Paris 1822, in which the theorem originally appeared.

Fourierism. A system of political and social government has been so called from the name of its founder, or rather imaginer, Charles Fourier of Besançon. [SOCIALISM.]

Fourth. In Music, one of the harmonical intervals; so called as being the fourth in order of the natural or diatonic scale from the fundamental. The ratio of the vibrations of the two sounds producing the interval of the fourth is 3 : 4.

Fousel Oil or **Fusel Oil** (Gr. φύω, *I produce*). An oil contained in corn-spirit and potato-spirit, which gives to those liquors a disagreeable taste and smell. When purified it constitutes the *amylic alcohol*, or hydrate of oxide of amyle, of modern chemists; its formula is $C_{10}H_{11}O+HO$. [AMYLE.]

Fovilla. In Botany, the matter contained within the grains of pollen.

Fowler's Mineral Solution. A solution of *arsenite of potassa* introduced into medicine by Dr. Fowler of Stafford, as a substitute for a similar preparation, sold as a quack medicine, under the name of *Tasteless Ague Drops*. The *Liquor Arsenicalis* of the Pharmacopœia is for the same purpose.

Fowling. The art of catching birds with nets, birdlime, decoys, or other devices. It is also used for taking birds with hawks, falcons, and other birds of prey; more properly called *falconry* and *hawking*.

Fox. [VULPES and CANIS.]

FOX. A particular kind of strand made of rope-yarns.

Foxglove. The *Digitalis purpurea*, a common indigenous plant, the leaves of which, when carefully dried and powdered, or made into a tincture or infusion, are used in medicine. In small and repeated doses it lowers the pulse in an extraordinary manner, and produces debility and fainting; combined with other remedies, it forms an ingredient in some powerful *diuretics*. [DIGITALIS.]

Fraction. In Arithmetic, one or more aliquot parts of unity. In order to form a precise idea of a fraction of any unit, we must consider the unit to be divided into a certain whole number of equal parts, of which parts we take one, two, three, &c. The expression of a fraction therefore necessarily involves two whole numbers; namely, one to denote the number of parts into which the unit is divided, and the other to express how many of these parts are to be taken to form the fraction. The first of these numbers is called the *denominator*, and the second the *numerator*, and the fraction is denoted by placing the numerator above the denominator with a line or bar between them. Thus *seven eighths* is represented by the symbol $\frac{7}{8}$.

A fraction may also be regarded as the quotient that arises from the division of its numerator by its denominator. For example, the expression *seven eighths*, or seven times the eighth part of unity, is identical with the expression *the eighth part of seven units*, or *seven divided by eight*.

From the above definitions of the numerator and denominator of a fraction, the following consequences result: 1. If, without altering the denominator of a fraction, we multiply or divide its numerator by any number, the new fraction will be so many times greater or less than the original fraction. 2. If, without altering the numerator, we multiply or divide the denominator of a fraction by any number, the new fraction will be so many times smaller in the former case, and so many times greater in the latter, than the original fraction. 3. The value of a fraction is not altered by multiplying or dividing both numerator and denominator by the same number. It is on these

three principles that the practical rules for the addition, subtraction, multiplication, and division of fractions are grounded.

A fraction whose numerator and denominator contain no common factor is said to be in its *lowest terms*. A *proper fraction* is one whose denominator exceeds its numerator; whose value, consequently, is less than unity. A fraction whose numerator exceeds its denominator, and which is consequently greater than unity, is said to be an *improper fraction*. Such a fraction may be expressed as a sum of a whole number and a proper fraction; thus, $\frac{16}{7} = 2 + \frac{2}{7}$. This result, written in the form $2\frac{2}{7}$, is called a *mixed number*. A fraction whose numerator and denominator consist of other fractions or mixed numbers is termed a *compound* or *complex fraction*, to distinguish it from the simple fraction to which it may always be reduced. Thus $\frac{2\frac{1}{3}+\frac{1}{2}}{1+\frac{7}{8}}$ is a complex fraction equal to the simple improper fraction $\frac{68}{45}$ or to the mixed number $1\frac{23}{45}$. For one very important class of complex fractions, see CONTINUED FRACTION.

Fractions whose denominators are powers of 10 are termed *decimal* fractions, and are expressed by a different notation. [DECIMAL FRACTION.]

Fraction, Vanishing. An algebraical fraction which, under a certain hypothesis, assumes the indeterminate form $\frac{0}{0}$. Thus $\frac{x^2-1}{x-1}$ is a vanishing fraction when $x=1$. The true value of a vanishing fraction is the limit to which it approaches, as the hypothesis which causes the fraction to vanish is gradually approached. Thus, as x approaches the *critical value* 1 in the above example, the fraction approaches the limit 2. The general method of finding the true value of a vanishing fraction is to replace its numerator and denominator by their differential coefficients, and to substitute in the result the critical value of the variable; should the fraction thus derived be again a vanishing one, the operation must be repeated. Thus, for $x=1$

$$\frac{a^x - a}{b^x - b} = \frac{a^x \log a}{b^x \log b} = \frac{a \log a}{b \log b}.$$

Fractions, Partial. [PARTIAL FRACTIONS.]

Fracture (Lat. fractura, from frango, *I break*). In Mineralogy. When minerals are broken, they either exhibit a smooth regular surface, to which the term *cleavage* is generally applied; or they give an irregular or uneven surface, termed a *fracture*. Werner, who first employed this character in his description of minerals, divides their various fractures into compact, fibrous, radiated, and foliated. The terms *earthy*, *granular*, *uneven*, *hackly*, and *splintery*, the meanings of which will be sufficiently obvious, are employed by other mineralogists.

FRACTURE. In Surgery, this term is limited to broken bones. Such accidents are generally the result of external force; but it sometimes happens that the powerful action of certain muscles may cause a *fracture*, as is [illegible] the case in regard to [illegible]. Fractures are distinguished by surgeons into *transverse*, *oblique* and [illegible] upon the direction in which the bone is broken, and into *simple* and *compound*, depending upon the circumstances with which the injury is accompanied. By *simple fracture* surgeons mean a suddenly formed breach in the continuity of one or more bones, without any external wound communicating internally with the fracture; by a *compound fracture* they signify the same sort of injury of a bone or bones attended with a laceration of the integuments, which laceration may be produced by the protrusion of one or both ends of the fracture through the skin, or by a ball or other body which enters or otherwise wounds the soft parts at the same moment that it breaks the bone.

Frænum. [FRENUM.]

Fragaria (Lat. fraga, *strawberries*). The Strawberry plant forms a genus of *Rosaceæ* known by its ten-cleft calyx, its five petals and its seeds inserted on a fleshy receptacle. This latter forms the fruit known as the Strawberry, one of the most grateful and wholesome of all our hardy fruits. The varieties of the Strawberry are very numerous, and come from several distinct species, the principal of which are *F. vesca*, *elatior*, *virginiana*, *grandiflora*, and *chilensis*.

Fragmentary Rocks. A geological term applied to rocks apparently composed of the agglutinated fragments of other rocks. *Breccias* and *conglomerates* are of this class.

Fraises (Fr.). In Fortification, a defensive obstacle formed by driving pointed stakes at a small angle with the horizon into the edge of the ditch of a work, &c.

Framboesia (Fr. framboise, *a raspberry*). The yaws; a disease endemic in the Antilles and some parts of Africa, which is attended by cuticular excrescences something like raspberries, which discharge a watery fluid. It is contagious, but not dangerous.

Framing. In Architecture, the rough timber work of a house, including floors, roofs, partitions, ceilings, and beams. Generally any pieces of wood fitted together with mortises and tenons are said to be framed together; as doors, sashes, sash-frames, &c.

Franc. A coin in use in France, equivalent to 9·69*d.* [MONEY.]

Franchise (Fr. from the Teutonic frank, *free*). In Law, a species of incorporeal hereditament, synonymous with liberty, which is defined, 'A royal privilege or branch of the king's prerogative, subsisting in the hands of a subject.' For an account of the nature of the *elective franchise*, see PARLIAMENT.

Franciscans. One of the four Mendicant Orders, founded by St. Francis of Assisi, in Umbria, in the year 1209. [ORDERS, MENDICANT.]

Francoaceæ (Francoa, one of the genera). A natural order of hypogynous Exogens of the Erical alliance, distinguished especially by their

polypetalous flowers, their free stamens half of which are sterile and scale-like, and their tight-skinned seeds. The species of *Francoa* are regarded in Chili as cooling and sedative, and their roots dye black.

Frank. A privilege enjoyed by the members of both houses of parliament, some government offices, and certain public functionaries, of sending and receiving a certain number of letters *post free*; abolished Jan. 10, 1840. [POSTAGE.]

Frank Aleu. This word is still used in Lower Canada, and also in Guernsey and Jersey, to denote land acknowledging no feudal superior, and consequently not a *tenure*. [FEUDAL SYSTEM.]

Frankalmoign (from two Norman-French words, signifying *free alms*). In Law, a tenure by spiritual service, where an ecclesiastical corporation, sole or aggregate, holds land to them and their successors of some lord and his heirs in free and perpetual alms. Donations in frankalmoign are now out of use, as none but the king can make them; but they were expressly excepted from the operation of stat. 12 Ch. II. c. 24, which abolished military tenures.

Frankeniaceæ (Frankenia, one of the genera). A small natural order of hypogynous Exogens, of the Violal alliance, chiefly remarkable for their polypetalous flowers, tubular furrowed calyx, and hypogynous clawed petals. They are chiefly natives of North Africa and Southern Europe, and are of little general interest.

Frankincense (said to be so called from its liberal distribution of odour). The gum-resin *Olibanum*, which is the produce of the *Boswellia thurifera* or *serrata*, and is imported from the Levant, bears the commercial name of *frankincense*. When it is burnt, or sprinkled upon hot coals, it exhales a very fragrant and diffusible odour.

Franklinite. A ferriferous oxide of zinc occurring in New Jersey, North America; named in honour of Dr. Franklin.

Frankpledge or **Freeborg** (Ger. bürge, *pledge*). A celebrated Anglo-Saxon usage, which appears to have been of two kinds. 1. That which may be termed *seignorial frankpledge*, by which every lord (hlaford) was rendered responsible for the appearance of his own *men* or dependants, when accused before justice in the hundred court; when, if the party absconded, the lord became liable to the king in the amount of the *were* or amercement for the offence. 2. Collective or public frankpledge (in which sense the word is most commonly used by modern writers) is of very obscure origin, but appears to have existed after the Conquest in the southern and eastern parts of England. The burghers and ceorls, or inferior class of freemen, were enrolled in small collective bodies termed *tythings* or *decennaries* (in many instances equivalent to the townships), under the superintendence of a chief pledge or tything-man. The tything thus organised was bound for the appearance of any one of its members under accusation. The 'view of frankpledge' originated in the usage of calling together the individuals who were enrolled in each of these bodies at certain stated times; these meetings were usually held at the court leet, but were not (as Blackstone states it) the main object of that institution, since courts leet were held from an early period in the northern parts of England, in which frankpledge never existed, as well as in the southern. On the view of frankpledge, the members of each tything also took the oath of allegiance under the Norman kings. (Turner's *Anglo-Saxons*; Sir F. Palgrave's *Commonwealth of England*.) [COURT, LEET.]

Frapping. On board Ship, is to increase the tension of parallel ropes by binding them together or drawing them towards each other, and therefore tightening them: in desperate cases, even the ship itself may be frapped by cables passed right round the hull to secure unsteady timbers and impart rigidity.

Fratercula. The generic name for the puffins. [MORMON.]

Fraternities (Lat. fraternitas). Associations of laymen in the middle ages, formed for the purposes of general benevolence, and for the discharge of other Christian duties.

Fratricelli (Ital.). In Ecclesiastical History, a sect of Franciscans, founded in Italy towards the close of the thirteenth century, by Maurato and Fossombroni. They made all perfection to consist in poverty, and were condemned by Boniface VIII.; but although it is said that two thousand of their number were burnt by the Inquisition in the fourteenth and fifteenth centuries, the sect existed down to the time of the Reformation, when its members took up the doctrines of Luther.

Fraud (Lat. fraus). In Law, the general name for any species of deceit in contracts, either by suppression of truth or assertion of falsehood. The most complete definition of it is that given by Forbes: 'Dolum malum esse omnem calliditatem, fallaciam, machinationem, ad circumveniendum, fallendum, decipiendum alterum adhibitum.' (Story's *Commentaries on Equity Jurisprudence*.) With a view to the provisions of the English law, frauds may be divided into such as are cognisable by courts of common law, such as are cognisable in equity only, and such as are expressly provided against by statutes. It has been laid down as a general principle, that courts of common law can relieve against the consequences of fraud (by making contracts void, &c.) as well as courts of equity, wherever the fraud is clearly established; and that their inadequacy to provide a proper remedy arises only from their inability to attain the necessary evidence. But however this may be, it has long been a general principle, that courts of equity, in the language of Lord Coke, have jurisdiction over frauds, covin, and deceits, for which there is no remedy by the ordinary course of law. Hence arises one of the three great branches of equity jurisdiction — trust, fraud, account. [CHAN-

CELLOR.] The general principles of that jurisdiction appear to be, that the courts will relieve, by considering acts as performed of which the performance has been fraudulently prevented; by setting aside bargains made in ignorance of rights, or where there is material concealment of title, value, &c.; or, finally, misrepresentation in material particulars. Various acts have been made fraudulent, so as to produce the consequence of annulling contracts and avoiding conveyances by statutes: e. g. conveyances with intent to defraud creditors, by 13 Eliz. c. 5; voluntary conveyances, 27 Eliz. c. 4; various contracts, conveyances, &c. not executed with the formalities required by the Statute of Frauds, 29 Ch. II. c. 3. Some frauds are of a criminal nature, and punishable by indictment; but they are chiefly such as affect the public, or such as are effected by means of false tokens.

By the statute 24 & 25 Vict. c. 96 s. 75 (1861) frauds committed by bankers, merchants, brokers, attorneys, and other agents, in virtue of their employment as such, are made in certain cases misdemeanours, and punishable by penal servitude.

Constructive fraud is said to be any act or contract such as, though not originating in any actual evil design, or contrivance to perpetrate a positive injury upon other persons, yet by its tendency to deceive or mislead other persons, or to isolate public or private confidence, or to impair or injure the public interests, is prohibited by law as within the same mischief as intentional fraud. Such are, in English law, marriage-brokerage bonds, various transactions between parent and child, attorney and client, dealings by trustees with the property of their cestuis que trust, voluntary conveyances, and so forth.

Fraudulent Conveyances. In Law, made void by statutes, are either such as are made with express intent to defraud purchasers and creditors; or voluntary conveyances, from which the law implies such intent.

Fraunhofer's Lines. The dark lines which cross the solar spectrum at right angles to its length; so named after Fraunhofer, who first examined them. [SPECTRUM.]

Fraxinus (Lat.). In Botany, the genus which comprises the Ash-tree. It is a member of the order *Oleaceæ*, and is known by its dry two-seeded compressed winged fruits. The Common Ash, *F. excelsior*, is one of the most useful of European trees, affording not only an object of picturesque beauty, but a most valuable timber, which from its toughness and elasticity ranks as one of the most important of our native woods. For Manna Ash, see ORNUS.

Freckles (Old Norse, frekna; Ger. flecken von der sonne: Wedgwood). Small yellow specks and spots which appear upon the face, especially of fair persons much exposed to the weather. The best application is a dilute spirituous lotion (one part of brandy to eight of water), with a few drops of muriatic acid, so as to render it just perceptibly sour.

Free Bench. In Law, a widow's customary dower out of copyholds. It differs from dower mainly in this, that it only attaches on lands of which the husband dies seised.

Free Church of Scotland. The name assumed by that large body of Presbyterians in Scotland which seceded from the established church in 1843. [VETO.]

Since that time this religious body has continued to flourish in Scotland. In 1851, the period of the last religious census, it had 570 churches complete and 70 building. It has been roughly estimated to comprise 32 per cent. of the inhabitants of Scotland (the established kirk comprising about 34 per cent.). The standards of belief in the Free Church are the Confession of Faith, and the Larger and Shorter Catechisms; besides the Directories and the Form of Church Government, which are to be used rather as regulations than tests. They have, like the kirk, a general assembly. Their ministers are chosen by the members of the church. They have three theological halls, in Edinburgh, Glasgow, and Aberdeen, for the education of ministers; and they have now synods in connection with their church in most of the principal British colonies, although the causes which led to their original disruption from the kirk can scarcely be said to have existed there.

Free Imperial Cities. In the history of the Empire, certain cities which acknowledged no head but the emperor, and were governed by their own magistrates. This privilege constituted them virtually independent republics. Some of these cities formed the Hanseatic league in 1241: that of the Rhenish cities was formed in 1246. [HANSA, HANSE, or HANSEATIC LEAGUE.]

Free Stone. A name applied technically to any kind of stone which may be worked freely, in contradistinction to those that are worked only by the pick or the hammer.

Free Trade. In Political Economy. The principle which underlies all the arguments used by those who advocate free trade, is that no duty should be imposed on any commodity consumed in order to give an advantage to the home producer, or to supply any compensation in consideration of certain colonial or treaty interests. The doctrine that exchange should be free in order to be healthy, is an economical axiom; invasions of this doctrine never having been defended, except on the ground that political expediency or particular burdens justify the violation of a natural law. The support of free-trade principles does not imply that duties on imported commodities must necessarily be abandoned in any sound system of finance, but that such duties should be imposed for revenue purposes only, should not be differential, and if levied on articles manufactured at home, should be coupled with a corresponding excise on home produce.

The arguments alleged by free traders are partly scientific and partly empirical. The object of a protective duty is clearly to raise prices, or in other words to compel a charge for

an equal or inferior article in excess of its natural or market price. This is plainly a wrong to the community at large, that is to the mass of purchasers. Nor if a protection were accorded to every producer, would matters be mended. At best the result would be a general rise in prices, in which no one would be benefited, or rather in which everyone would have an inferior article at greater cost. But economical progress depends upon the decreasing cost of production. Hence the plain common sense of free trade and the mischief of protection have been exhibited in a homely formula: that all protection means robbing some one else, the result of universal protection being that everyone could be robbed. Now a system which inflicts manifest injury on the community, needs very powerful reasons for its defence. But it has been found that the reasons alleged are either not sufficient to justify this invasion of natural liberty, or more frequently are baseless and visionary. Again, it is clear that any attempt to regulate prices seriously affects the operation of competition; and consequently, by making values unsettled and fluctuating, causes that to be doubtful which it is the highest interest of the prudent trader to make as certain as possible. The advantage of producer and consumer is equally compromised by unsteady prices.

Secondly, experience has perpetually confirmed the theoretical propriety of free trade. It has been found, first, that increased demand has given greater aggregate profits to unprotected producers, by extending the margin of consumers; and secondly, that capital has flowed more freely, and has been applied more beneficially to employments which government has not pretended to support. The Lancashire manufacturers were convinced so early of this truth, that they petitioned parliament long ago to be freed from the disadvantage of protection. Low prices do not mean low profits; and small profit on single transactions may, if the market be wide, mean great profit in the aggregate.

The natural propriety of free trade was demonstrated in this country by Adam Smith, and exhibited with singular clearness in the merchants' petition drawn up in 1820 by the late Mr. Thomas Tooke. Unfortunately, however, the pressure of a great war, and that ignorance of the simplest economical principles which characterised almost all the statesmen of the early part of the nineteenth century, postponed the consideration of the best way in which national wealth might be increased. The practical demonstration of the wisdom implied in the adoption of free-trade principles was the work of the Anti-Corn-Law League, and particularly of the late Mr. Cobden. When the corn laws were abandoned, the principle of protection was in effect surrendered, for the victory of the League assailed the protective system in its most vital part. [Protection.]

It must not be imagined that free trade has been as yet accepted in this country in all its details. The chief result of the assent given to its axioms is to be found in the acceptance of the principle, in the continual necessity put upon those who are protected to defend their status, and in the application of the rule to finance. It cannot be doubted, however, that much more work remains to be done, before the rule of free trade is applied to all transactions and all interests.

But little progress has been made in other countries in the direction of commercial freedom. The protective system prevails generally on the Continent, though many distinguished economists have exposed and refuted it: of these, none has been more cogent in argument, and more felicitous in illustration, than Bastiat, whose premature death was a very great loss to France. As a rule, professed economists have been urgent in the exposition of free trade doctrines; and those who have studied the conditions and causes of national wealth have rarely failed to range themselves under the banner of free trade.

Freebooters (Ger. freibeuters). A name given to some adventurers of all nations, but especially of France and England, who have been conspicuous for courage and intrepidity in executing the most difficult enterprises, and who have made free to appropriate as booty whatever fell under their hands. Their early history is obscure. The South American islands formed the chief theatre of their depredations; and during the latter half of the seventeenth century, they nearly destroyed the commercial operations of the Spaniards in the Indian seas. At the commencement of the eighteenth century, the freebooters sustained a series of disasters, which sensibly diminished their numbers; and since that period the name has been applied indiscriminately to anyone who regards 'the universe as his property,' and appropriates to himself either furtively or forcibly the possessions of another. [Filibusters.]

Freedmen. In the ancient Greek and Roman Law, the freedmen, or persons manumitted from slavery, formed a distinct class. Although no longer subject to the will of their former master, they were still not free of all relations to him. At Athens the freedman, or one in the state of ἀπελευθερία, still had to regard his former lord as his προστάτης or patron. In Rome, the freedman was called *libertus*, with reference to his master; but the class to which he belonged was termed that of the *libertini*. These also remained subject to many disabilities.

Freedom. [Liberty.]

Freehold. In Law, a term which is used in two different senses: 1. To express the quantity of estate which a man may have in lands or tenements; and, 2. To express a tenure by which lands and tenements are held. Thus, an estate of freehold, to satisfy the full acceptation of the term, must be both sufficient in quantity of interest and sufficient in tenure.

1. As to quantity of interest, all estates for a term uncertain in duration are estates of freehold; and they are divided into estates of inheritance, and not of inheritance. The first of these are either absolute (fee simple) or limited

(fee tail, or fee simple conditional). The second are estates for life, or for an uncertain period limited within the term of a life; as, an estate granted to a widow *durante viduitate*. Such estates as this are by the law regarded as estates for life, determinable on a given event. 2. With respect to tenure, freehold tenure is derived from the ancient free socage; and lands held by copy of court roll according to the custom of a manor, viz. copyholds, are not within this denomination. But lands held by custom of the manor, *not* by copy of court roll, are not copyholds, but customary freeholds.

In order, therefore, to give the privileges or impose the duties attached by the law to freeholders (such as serving on juries, voting at county elections, &c.), the estate in respect of which such right or duty attaches must be either for life or a greater interest, and must be held in freehold tenure.

Freeman. In Mediæval Law, one free from servitude, as distinguished from a bondman. The term is now applied to those who have the freedom of a city or borough.

Freemasonry. A well-known institution, the origin of which has given rise to much fabulous narrative and idle speculation. Some derive the mysteries of Freemasonry from those of the priests of Eleusis, and these again from Egypt; others from the secret associations of the Templars. [Templars; Baphomet.] The last opinion was illustrated at great length by M. Barruel (*Mémoires du Jacobinisme*), who fancied both Freemasons and Jacobins to be the relics of a long-established conspiracy for the subversion of religions and empires. A corporation of architects and engineers existed in ancient history under the name of the Dionysiacs of Ionia. They monopolised the building of temples, stadia and theatres, and recognised each other by signs and tokens. A similar fraternity of architects or builders in the middle ages extended over all Catholic countries, and was especially patronised by the see of Rome. It is to this craft that we owe the magnificent Gothic edifices dedicated to religion, which contrast so strongly with the barbarous efforts of those ages in most other departments of art. It is said that this association was introduced into Scotland in the thirteenth century, and about the same time into England, it being ascertained that the abbey of Kilwinning, in the former country, was raised by this fraternity; and it is believed to have continued to exist in these two countries after it had disappeared from the Continent. The Kilwinning and York lodges are respectively the most ancient in either country. The withdrawal of the patronage of the church consequent on the increased supply of architects, the tendency of freemasonry to reject the principles of the church of Rome, and the bloody civil wars of the middle ages, account for the decay of the fraternity in its professional character. But although a severe Act was passed by parliament against the association, in 1425, it appears never to have been carried into execution: and King Henry VII. was succeeded as grand-master of the order by Cardinal Wolsey. The office has since been held by several of the kings of England. The first regular grand lodge in London was formed in 1717. The Scottish masons appointed St. Clair of Roslin their hereditary grand-master in 1630; and the office was resigned by his descendant in 1736, when the grand lodge of Scotland was instituted. In 1725, the first French lodge was established; in 1730, the first American; in 1735, the first German. From that period until the present, while the society has existed among ourselves as a mere convivial and benevolent association, and has been patronised even by royalty and the nobility, it has been subjected on the Continent to a variety of suspicions; and it is most probable that political intriguers have availed themselves of the secrecy afforded by it to further their schemes. Indeed, in this country, the 'Royal Arch' degree is said to have been devised by the Scottish Jacobites. Pope Clement XII. excommunicated the Freemasons in Spain and Portugal, where their name was synonymous with that of deists and revolutionists.

The reports of proceedings in grand and private lodges are now published in the *Freemason's Magazine*. (Lawrie's *History of Freemasonry*, Edin. 1804; Anderson's ditto; Preston's *Illustrations of Masonry*; the German *Freimaurer Encyklopädie*, &c.)

Freethinker. A term, usually of reproach, applied to those who reject the ordinary modes of thinking in matters of religion. It is almost synonymous with Deist [which see].

Freezing Mixtures. When five parts of powdered nitre and five of powdered sal ammoniac are mixed with sixteen parts of water the thermometer falls in the mixture from 50° to about 10°; so that in this way a degree of cold much below the freezing point of water may be artificially and cheaply obtained, for the salts may be again procured by evaporation and used repeatedly. When ice or snow can be obtained, the most effective freezing mixture is produced by mixing it with about half its weight of salt; it carries the thermometer nearly to 0°. The utmost degree of cold produced by the skilful combination of the best freezing mixtures has not exceeded 140° below 0°.

Freight (Ger. fracht). In Mercantile Law, the sum paid by a merchant or other person hiring a ship, or part of a ship, for the use of such ship or part of it for a specified voyage, or for a specified time. Freight must be mentioned, eo nomine, in a policy of insurance, and is not covered by a policy on goods.

French Berries. The fruits of several species of *Rhamnus* used for dyeing, as those of *R. infectorius*, *saxatilis*, *amygdalinus*, &c.

French Chalk. A white or greyish kind of Steatite, used for taking grease out of silk, and for slate-pencils.

French Polish. A solution of shell-lac in spirit of wine is the basis of this compound; a

small quantity of linseed oil is added to it at the time of its application, and it is laid on by a ball of cotton-wool and rapidly rubbed in the direction of the fibres of the wood; when dry, it is finished off by friction with tripoli and oil.

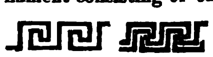
French White. Finely pulverised Talc.

Frenum (Lat. *a rein*). In Anatomy, a name given to some membranous ligaments of the body, as the *frenum linguæ*, or ligament of the tongue.

Fresco Painting (Ital. fresco, *fresh*). A method of painting by incorporating the colours with the fresh or wet wall plaster, or *sul fresco intonaco*, upon the *fresh* coat. When dry, such paintings become as permanent as the wall itself. This method is very ancient. It was used by the Greeks, and can be traced even to Egypt, for ordinary purposes of mere wall colouring or staining; but for works of high art, it was not developed until after the time of Giotto; and the first genuine fresco painting, called *buon fresco*, is supposed to be the work of Pietro d'Orvieto, executed in the Campo Santo at Pisa, in 1390. The earlier wall paintings are executed in what the Italians, to distinguish it from *buon fresco*, now call *fresco-secco*, or dry fresco, literally a contradiction. But in the case of *secco* painting, the dry wall was well saturated with water, and the tints, all mixed with lime, were applied while the wall was wet, and when drying were, through the immixture with lime, incorporated with it. *Buon fresco* can only be executed in small portions, just as much as the painter can execute in a single day; the parts therefore marked out for the day's work are distinct portions of figures or objects, which are not injured by being surrounded by a sharp outline. (See the article 'Fresco' in the Supplement to the *Penny Cyclopædia*; the *Appendices to the Reports of the Commissioners on the Fine Arts* for 1842 and 1843; and Mrs. Merrifield's *Art of Fresco Painting, &c.* London 1846.)

Freshwater Deposits. All materials thrown down after suspension in water, or conveyed by moving water and left behind when the current has diminished in force, or left behind after the evaporation of water, are strictly *aqueous deposits*. [AQUEOUS ROCKS.] Of these it is clear that some will be due to rivers, lakes, and fresh water filtered into caverns or rising in springs, and the rest to the sea. The former come under the general designation of *freshwater deposits*, and contain usually some marks of adjacent land, or of lakes, or pools. Thus fragments of leaves, insect cases, shells of snails, and shells of lymneas or planorbis, and even bones of quadrupeds, are amongst them. They are not so large or abundant as marine deposits, but are often interesting as indicating the position of ancient land.

Fret (Fr. frette). In Architecture, an ornament consisting of one or more small fillets, meeting in vertical and horizontal directions. The section of the channels between the fillets is irregular. The



preceding diagram shows two sorts of simple frets; but they are often much more complicated in their design.

Frets. The cross bars on the finger-boards of stringed instruments of ivory or brass, by pressure whereon with the finger the string is stopped to produce a certain note in the scale. The use of frets is still continued on the Spanish guitar, and they were formerly in constant use for learners upon what was called the bass-viol; they were taken off when the pupil had learnt by practice to measure the accurate distance of the stops. On lutes and viols they were always permitted to remain.

Freya. [ODIN.]

Friability (Lat. friabilis, *that may be broken*). The property by which substances admit of being crumbled into powder by gentle friction.

Friar (Fr. frère, Lat. frater, *brother*). A brother or member of any religious order; but more exclusively applied to those of the Mendicant Orders, of which the four chief were the Dominicans (Black Friars), Franciscans (Grey), Carmelites (White), and Augustines. [ORDERS, MENDICANT.]

Friar's Balsam. The *compound tincture of benzoin* of the London Pharmacopœia. It is an alcoholic solution of benzoin, styrax, tolu balsam, and aloes; it is used as a stimulating application to wounds and ulcers.

Friction (Lat. frictio, from frico, *I rub*). In Mechanics, the resistance produced by the rubbing of the surfaces of two solid bodies against each other. If the surfaces of bodies were perfectly smooth and polished, they would slide along one another without suffering any resistance from their contact, and all the simple relations between power and resistance determined by theory in respect of the different machines would hold good without any modification whatever. But this state of perfect polish never exists. The surfaces of all bodies with which we are acquainted, even when most carefully polished, retain a greater or less degree of asperity, which prevents them from sliding over one another without impediment; and in many cases the resistance thus created amounts to a large proportion of the whole resistance to be overcome. In order, therefore, to ascertain the real value of the effect of powers applied to machinery, it is necessary to determine the amount of the friction, and to add this new resistance to that which is given by the theory of mechanics.

The determination of the laws of friction, and of its amount with respect to particular substances, has occupied the attention of many experimental philosophers and mathematicians, as Amontons, Euler, Desaguliers, Vince, &c.; but the first complete set of experiments on the subject was made by Coulomb about the year 1780. His results, though they have been partly modified by subsequent experiments, throw much light upon the subject, and are of great value to the practical engineer.

Assuming the pressure as equal to 100 parts,

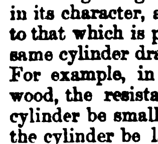
the friction of oak against fir was 66 in the direction of the fibres, but amounted only to 16 when moved with the velocity of a foot each second; the friction of oak against oak in the direction of the fibres was 43, and across them only 27, the effect being further reduced by motion to 10; the friction of fir against fir in the direction of the fibres was 56, which sank to 17 during motion; the friction of elm against elm in the direction of the fibres was 46, and reduced by motion to 10. On the other hand, the friction of copper upon oak, lengthwise, was 8 at the commencement of the motion, but increased to 18 when the velocity was a foot in a second; the friction of iron upon oak with the initial velocity was 11, and was increased by the motion to 18. But the mutual friction of metals appeared in general to be scarcely, if at all, affected by motion. In these experiments no unguents were used.

Coulomb also investigated the effect of velocity upon the friction of rubbings urfaces, and also the influence of pressure and extent of surface upon friction. The following is a brief summary of the general results of Coulomb's experiments respecting the friction of bodies *sliding* on each other.

1. Between similar substances, under similar circumstances, friction is a constant retarding force. 2. Friction is greatest between bodies whose surfaces are rough, and is lessened by polishing them. 3. It is greater between surfaces composed of the same material, than between the surfaces of heterogeneous bodies. 4. If the rubbing surfaces remain the same, the riction increases directly as the pressure. 5. If the pressure continue the same, the friction has no relation to the magnitude of the surface. 6. The application of grease in general diminishes the friction, though in very different degrees.

The obstruction which a cylinder meets with in rolling along a smooth plane is quite distinct in its character, and far inferior in its amount, to that which is produced by the friction of the same cylinder drawn lengthwise along a plane. For example, in the case of wood *rolling* on wood, the resistance is to the pressure, if the cylinder be small, as 16 or 18 to 1,000; and if the cylinder be large, this may be reduced to 6 to 1,000. The friction from sliding, in the same cases, would be to the pressure as 2 to 10, or 3 to 10, according to the nature of the wood. Hence, by causing one body to roll on another, the resistance is diminished from 12 to 20 times. It is therefore a principle in the composition of machines that attrition should be avoided as much as possible, and rolling motions substituted whenever circumstances admit.

On this principle depends the advantage resulting from the application of *friction wheels* and *friction rollers*.



The extremity of an axle C, instead of resting in a cylindrical socket, is made to rest on the circumferences of two wheels, A and B, to the axles of which, *a* and *b*, the friction is transferred, and consequently diminished in the ratio of the radius of the wheel A to the radius of the axle *a*. This ingenious contrivance appears to have first been applied by Henry Sully, in the year 1716. (*Descr. Abrégée d'une Horloge, &c.* Bordeaux 1716.)

The following are deductions from Coulomb's experiments relative to the friction of rolling bodies: 1. Like the friction of sliding bodies, it is a constant force. 2. It is affected by the nature of the surface so far as polish is concerned; but is not lessened by the interposition of unctuous substances. 3. It is less between heterogeneous than between homogeneous substances. 4. It is directly proportional to the pressure. 5. It has no relation to the magnitude of the surface. 6. It is much less than in the case of sliding surfaces, and varies in the inverse ratio of the diameter of the rolling body.

The friction of the axle of a wheel or pulley (whether the axle itself turns, or the wheel turns on the axle) is of a different kind from that of a cylinder rolling on a plane. It is less than that of sliding, but greater than that of rolling bodies, and follows in all respects the laws of the friction of sliding bodies. A great advantage is here obtained by greasing the surfaces. By the application of fresh tallow the friction is reduced to one-half.

Coulomb's experiments were also directed to ascertain the resistance arising from the rigidity of ropes when bent round rollers or cylinders. The results are as follows: 1. The resistances of ropes are directly proportional to the tensions to which they are subjected. 2. The resistance increases with some determinate power of the diameter, and is greatest in ropes that have been strongly twisted, or are coated with tar. 3. The resistances are inversely as the diameters of the cylinders about which the ropes are bent.

When a rope is wound more than once round a cylinder, the resistance increases in a geometrical progression. This principle is frequently applied in practice: thus, in arresting the progress of a vessel, a rope is wound round a post, and a very few turns is sufficient to overcome any force which the rope is capable of withstanding.

A valuable series of experiments on friction was made by Mr. George Rennie, the details of which are given in the *Phil. Trans.* for 1829. The following are a few of the results: Assuming as before the pressure equal to 100 parts, the friction of steel upon ice is 1·4; ice upon ice 2·8; hard wood upon hard wood 13; brass upon wrought iron 13·5; soft steel upon soft steel 14·6; leather upon iron 25; granite upon granite 30; yellow deal upon yellow deal 35; sandstone upon sandstone 36; woollen cloth upon woollen cloth 43. Some of the conclusions deduced by Mr. Rennie are as follows: 1. In fibrous substances, such as cloth, friction is increased by surface and time, and diminished by pressure and velocity. 2.

In harder substances, such as woods, metals, and stones, the friction is directly as the pressure, with regard to surface, time, or velocity. 3. Friction is greatest with soft, and least with hard, substances. 4. The effect of unguents is as the nature of the unguents, with reference to the substances to which they are applied.

In the *Mémoires de l'Institut* for 1833, two very extensive sets of experiments are described, which were made by M. Morin, at Metz, under the auspices of the French government, for the purpose of verifying or correcting the results of Coulomb. In general, M. Morin's results differ widely in absolute amount from those of Coulomb, giving in some instances ratios three times as great; but they point to, and indeed fully establish, the same general conclusions. (Coulomb, *Théorie des Machines Simples*, Paris 1821, and *Mémoires des Savans Étrangers*, tom. ix. and x.; Ximenes, *Teoria e Pratica delle Resist. de Solidi ne' loro Attriti*, Pisa 1782; Vince, *Phil. Trans.* 1785; Rennie, *Phil. Trans.* 1829; Morin, *Mémoires de l'Institut*, 1833; *Encyclopædia Britannica*, art. 'Mechanics,' &c.)

Friction-wheels. [Friction.]

Friday (Ger. Freitag). The sixth day of the week. The name is derived from Freya [which see].

Friendly Societies or **Benefit Societies.** Voluntary associations of subscribers, for the purpose of forming a fund for the assistance of members in sickness, or other occasions of distress. It is supposed by Mr. Turner (in his *History of the Anglo-Saxons*) that the ancient guilds originated in associations of this kind. It is certain that in countries where the privileges of guilds are still permitted, the trading society is called on to contribute to the occasional wants of the members of each association. Of the various means that have been suggested in this view, and for enabling the poor to provide a resource against sickness and old age, none seem so likely to accomplish their object as the institution of friendly societies and savings-banks. The former are founded on a principle of mutual insurance. Each member contributes a certain sum, by weekly, monthly, or annual subscriptions, while he is in health; and receives from the society a certain pension or allowance when he is incapacitated for work by accident, sickness, or old age. Nothing, it is obvious, can be more sound than the principle of these associations. If a number of individuals under thirty or thirty-five years of age form themselves into a society, and subscribe each a small sum from their surplus earnings, they are able, owing to the general exemption from sickness until a comparatively late period of life, to secure a comfortable provision for themselves in the event of their becoming unfit for labour. Anyone who should trust to his own isolated efforts would plainly be placed in a far more hazardous position. Whenever an unfavourable contingency exists, the best and cheapest way of obviating its effects is by uniting with others, each subjecting himself to a small privation, so that none may be overwhelmed by any great calamity. Hence the paramount utility of the societies in question.

Benefit societies commenced their legal existence in January, 1793, and since that time have been a frequent object of legislation, the provisions of the Act 17 & 18 Vict. c. 101 being the principal rule for their present administration. For minute information on the subject, the reader is referred to Mr. Scratchley's work on *Associations for Provident Investment.*

Advantageous as has been the institution of these societies, it cannot be denied that they have too often been delusive. Great errors, for instance, have arisen from their fixing too high a scale of allowances. At their first institution they are necessarily composed of members in the prime of life; there is, therefore, comparatively little sickness and mortality amongst them. In consequence their funds rapidly accumulate; and the projectors are tempted to give too large an allowance to those members who are occasionally incapacitated. But the circumstances under which the society is placed at an advanced period are materially different. Sickness and mortality are then comparatively prevalent. The contributions to the fund decline at the time that the outgoings increase; and it has not unfrequently happened that the society has become altogether bankrupt; and that the oldest members had been left, at the close of a long life, destitute of all support from a fund on which they had relied, and to which they had largely contributed.

The latest Acts place friendly societies under the direct control of a government registrar, who grants a certificate for their establishment on seeing that the provisions of law are complied with in their regulations. The Act also divides these societies into *registered* societies, which are allowed to embrace only a portion, and *certified* societies, which embrace all the objects, contemplated by the statute. The latter only can invest their funds with the Commissioners for Reduction of the National Debt.

Friends, Society of. [Quakers.]

Friesland Green or **Brunswick Green.** An oxichloride or an ammonio-chloride of copper.

Frieze (Fr. frise, Ital. fregio). In Architecture, the member of the entablature of an order between the architrave and the cornice. It is always plain in the Tuscan; ornamented with triglyphs and sculpture in the Doric; in the Ionic, it is occasionally in modern or Italian architecture swelled, in which case it is called a *pulvinated* or *cushioned* frieze; and in the Corinthian and Composite, it is variously decorated according to the taste of the architect.

Friga. In Northern Mythology. [Odin.]

Frigate (Fr. frégate, Span. fragata). The name applied to a ship with one covered gun deck, and having her upper deck flush.

Frigid Zone. The space about either pole

of the earth terminated by the parallel of 76½ degrees of latitude. At this parallel the sun at noon, in the middle of winter, is 90 degrees from the zenith; and consequently, were it not for the refraction, would not be completely visible even at noon above the horizon. Within this parallel the sun continues invisible in winter, and constantly visible in summer, for a shorter or longer space of time, depending on the distance of the place from the pole, where the sun remains for one half the year above the horizon, and the other half below it. [ZONE.]

Frigidarium (Lat.). In ancient Architecture, the apartment in which the cold bath was placed. It is sometimes used to denote the bath itself.

Frilazin. Among the Anglo-Saxons, a class of persons answering to the Roman liberti. [FREEDMEN.]

Fringes. A term used in Optics to denote the coloured bands resulting from diffraction.

Fringilla (Lat. *a chaffinch*). A Linnæan genus of Passerine birds, characterised by a broad-based, sharp-pointed, strong, conical bill: now raised to the rank of a family, *Fringillidæ*; including the buntings (*Emberiza*), the crossbills (*Loxia*), the grosbeaks (*Coccothraustes*), the linnets (*Linaria*), canary-birds (*Canaria*), finches (*Carduelis*), and many exotic subgenera of seed and grain eating Conirostral birds.

Frith or **Firth** (Lat. fretum, *a narrow sea*). A term chiefly applied to a narrow and deep inlet of the sea upon a river, as the Frith of Forth in Scotland. This term corresponds to the *fiord* of the Danes and Norwegians, and belongs to the same root with Ger. *fahren*, to pass over (Gr. περάω, πόρος, as in βόσπορος); whence *ferry*, *ford*, *furt* (Ger.), as in Frankfurt, Erfurt, &c.

Frithsoken (A.-Sax.). In Law, a liberty of having frankpledge, or surety of defence.

Fritillaria. In Botany, a genus of Liliaceous plants, including the *F. imperialis* or *Crown Imperial*.

Fritt. The materials of glass are first mixed together, and heated, so as to expel water, and induce fusion: the mass thus obtained is called *fritt*.

Frog. [BATRACHIA and RANA.]

Frog or **Frush.** In Farriery, the hard projecting substance in the hollow of a horse's foot.

Frond (Lat. frons, frondis). A combination of stem and leaf in one organ, as in *Lemna*, *Marchantia*, and such plants. The term is also applied to the leaves of ferns.

Fronde, War of the. The war maintained by the malcontent partisans of the parliament in France, under the regency of Louis XIV., against the government of Cardinal Mazarin. The name of Fronde (*sling*) was given to this war in consequence of some incidents in a street quarrel, of which various accounts have been given. The party opposed to government was called that of the Fronde; and the word *frondeurs* has hence acquired in the French language the signification of discontented politicians. The French Record Department has lately published an extensive and curious collection of *Mazarinades*, political squibs of the period of the Fronde.

Frondose (Lat. frondosus, *leafy*). In Botany, a term applied to plants with leaves developed in an unusual manner either in regard to their number or size.

Frons (Lat.). In Mammalogy, the region of the cranium between the orbits and the vertex.

FRONS. In Ornithology, the space between the base of the bill and the vertex.

Frontal Bone. The front bone of the head, which forms the forehead.

Frontal Sinus. A cavity in the frontal bone, placed over the orbit, on each side.

Frontier (Fr. frontière, Ital. frontiera). The boundary of a state, or the territories adjacent to the boundary. The best frontier is the sea; the next best, great rivers or mountains, as the Rhine, Rhône, Alps, and Pyrenees. Prussia has the worst frontier of any European state.

Frontispiece. In Architecture, the face, or fore front, of a house, but more usually applied to the decorated entrance to a building. This term is also applied to the ornamental first page of a book, being, as the derivation implies, that part which first meets the eye.

Frontlet. In Ornithology, the margin of the head behind the bill of birds, generally clothed with rigid bristles.

Frost. [CLIMATE; ICE.]

Fruit (Fr.; Lat. fructus). In Botany, the ovary or the pistil arrived at maturity; but the term is commonly extended to whatever is combined with the ovary when it is ripe. It comprehends many kinds of what are commonly called *seeds*; as those of corn, buckwheat, caraway, parsley, &c.; as well as the succulent inflorescence of the pineapple, which is a mass of ovaries and their envelopes in a consolidated condition.

Frustules (Lat. frustum, *a fragment*). In Botany, a term applied to the joints into which the *Diatomaceæ* separate. They contain a large proportion of silex, and hence, being capable of retaining their form after the vegetable constituents have fled, they are often found preserved in a fossil state.

Frustum (Lat.). In Geometry, a part cut off from a solid. The term is rarely used except in the cases of pyramids and cones, and then it is usually understood to refer to that part of the solid which is included between any two *planes* of section.

Frutex (Lat. *a shrub*). In Botany, a plant whose branches are perennial, and proceed directly from the surface of the earth without any supporting trunk.

Fuchsia (after Leonard Fuchs, a German botanist). A plant belonging to the order *Onagraceæ*. The genus is distinguished by its long funnel-shaped four-parted coloured calyx, its four petals, its eight exserted stamens, and its long style. There are many distinct species,

but the most commonly cultivated Fuchsias are varieties produced by the skill of the hybridiser.

Fucus (Lat.; Gr. φῦκος, *seaweed*). A genus of seaweeds comprising those with olive-coloured flat or compressed forked fronds, such as *F. serratus* and *nodosus*. They furnish a large proportion of the seaweed thrown upon the shore, and collected as manure. Formerly they were used for making kelp.

Fuel (Nor. Fr. fuayl). Any combustible substance which is used for the production of heat constitutes a species of fuel; and in this extended sense of the term, alcohol, wax, tallow, coal-gas, oil, and other inflammable bodies which are occasionally used, especially in the chemical laboratory, as sources of heat as well as light, might be included under it. But the term *fuel* is more properly limited to coal, coke, charcoal, wood, and a few other substances, which are our common *sources of heat*, and as such are burnt in grates, stoves, fireplaces, and furnaces.

In this country coal, from its abundance and cheapness, is the commonly employed fuel; but where wood is abundant, or where its value is little more than that of felling it, it is used either in its original state or in the form of charcoal. But whatever substance is used, the essential ultimate elements of fuel are carbon and hydrogen; and the heat which is evolved by their combustion is derived from their combination at high temperatures with the oxygen of the air; the principal results or products of this combustion are carbonic acid and water, these escaping into the atmosphere by the flue or chimney generally attached to furnaces and fireplaces.

It is essential to good and profitable fuel that it should be free from moisture; for unless it be dry, much of the heat which it generates is consumed in converting its moisture into vapour: hence the superior value of old, dense, and dry wood, to that which is porous and damp; hence also the greater quantity of heat evolved during the combustion of charcoal as compared with that of wood, for even the driest wood always retains a certain quantity of water; hence also coke gives out more heat than pit coal, partly because it is absolutely dry, and partly because during the combustion or heating of coal, tar, oil, water, and inflammable gases are evolved, all of which carry off a certain proportion of the heat in a latent form. A pound of dry wood will, for instance, heat 35 pounds of water from 32° to 212°, and a pound of the same wood in its fresh state will not heat more than 25 pounds to the same temperature; the value, therefore, of different woods for fuel is nearly inversely as their moisture, and this may be roughly ascertained by finding how much a given weight of their shavings loses by thoroughly drying them.

Charcoal is itself very hygrometric, and when exposed to air increases in weight to the amount of 10 or 12 per cent., chiefly in consequence of the absorption of humidity: a pound of dry charcoal is capable of raising, when properly burnt, 73 pounds of water from the freezing to the boiling point.

The different kinds of pit coal give out variable quantities of heat during their combustion; upon an average, one pound of coal should raise 60 pounds of water from the freezing to its boiling point. The heating power of coke as compared with coal is nearly in the ratio of 75 to 69: a pound of good coke will heat from 64 to 66 pounds of water from 32° to 212°; its power, therefore, is about nine-tenths that of wood charcoal.

The value of dried turf and peat as fuel is liable to much variation, and depends partly upon their density, and partly upon their freedom from earthy impurities. A pound of turf will heat about 26 pounds of water from 32° to 212°, and a pound of dense peat about 30 pounds: by compressing and drying peat its value as a fuel is greatly increased.

The following table, by Dr. Ure, shows the quantity of water raised from 32° to 212° by one pound weight of the different combustibles enumerated in the first column; it also shows the number of pounds of boiling water which the same weight of fuel will evaporate, and the quantity of atmospheric air absolutely consumed during combustion. The quantity of air, however, as given in the last column, is much less than would be necessary in practice, where much of the air passes the fuel without coming into contact with it so as to have its oxygen consumed. The heating power also, as represented by this table, can seldom be *practically* attained.

Combustible	Pounds of Water which a Pound can raise from 32° to 212°	Pounds of Boiling Water evaporated by One Pound	Weight of Atmospheric Air at 32° required to burn One Pound
Dry wood . .	35·00	6·36	5·96
Common wood .	26·00	4·72	4·47
Charcoal . .	73·00	13·27	11·46
Pit coal . .	60·00	10·90	9·26
Coke . . .	65·00	11·81	11·46
Turf . . .	30·00	5·45	4·60
Coal gas . .	76·00	13·81	14·58
Oil, wax, tallow	78·00	14·18	15·00
Alcohol . .	52·00	9·56	11·60

Fueros. The term by which in Spain the peculiar rights and privileges of certain provinces are distinguished. It corresponds to the old French word *for* or *fors*; and is said to be derived either from the Latin word *forum*, or (more probably) from the Spanish *fuera*, which signifies *outside* or *without*, thereby indicating the difference between the administration of the provinces in which the fueros prevail from that of other parts of the Spanish monarchy. There can be little doubt that the origin of these fueros may be fairly associated with the political existence of the brave Cantabrians, who were never wholly subjugated to the Roman yoke, and who even when partially vanquished still maintained their ancient laws and customs inviolate. From their earliest origin the Basque Provinces enjoyed certain privileges unknown to the rest of the Spanish kingdom, and which,

though originally not reduced to writing, and existing like our own common laws in the traditions of the country, were mutually and religiously observed both by the monarch and the people. In this state they remained till the year 1235, when, on the accession of Thibault, a French prince, to the crown of Navarre, some misunderstanding arose respecting the nature and extent of the fueros, and it became necessary to embody them in a written code, which, with some considerable enlargement sanctioned by Charles V., was, down to the period of the last revolution, faithfully recognised by all the monarchs of Spain as the magna charta of the Basque Provinces, until the revolution of 1833; nor can it well be doubted that the Carlist war became a lengthened struggle chiefly from the skilful way in which a question of succession was mixed up with the subject of the Basque fueros.

Though the immunities of the provinces, Guipuzcoa, Alava, Biscay, and Navarre, exhibit considerable difference in detail, their main features are marked by a striking uniformity, the form of government in each province being essentially republican in all its branches. In the province of Biscay, for instance, which, with a few modifications, may serve as an example for the other provinces, the royal authority is purely nominal. The only privilege of the crown consists in nominating the corregidor, the highest officer in the state; but even this appointment is subject to the approval of certain members (called *deputation*) of the *junta* or states, in whose assemblies he has a seat and vote. In the junta is vested the chief management of affairs. This assembly forms, with the exception of the American congress, by far the most popularly constituted representative body in modern times, the right of voting being conferred on every man who possesses a domicile within the lordship; and its chief duties consist in administering the affairs of the commonwealth, in collecting the taxes, in providing for the protection and defence of the country, in nominating the official servants of the government, and in forming of itself a court of appeal from the decisions of the corregidor. Of the privileges and immunities of the province itself, the following are the principal: Freedom from paying any imposts but those due from the inhabitants to their own lordship, and which are fixed by themselves, and additionally whatever gratuitous contributions may be deemed necessary to meet the extraordinary emergencies of the state; the enjoyment of the privileges of nobility in the Castilian dominions on merely proving a descent from pure Biscayan blood; exemption from appearing before any tribunal beyond the limits of the lordship; to tolerate no royal intendant or comptroller within the province; to permit no *estanco* or royal monopoly, as in the rest of Spain; exemption from duty on imported merchandise; to have no royal administration, except that of the post-office; to admit no Spanish troops within the territory; to furnish no recruits for the royal army; to defend their territory with their own means and blood; and to visit with summary punishment all who may be convicted of extortion, or of any attempt to injure or even to interfere with the constitution of the province. (Hallam's *Middle Ages*, ch. iv.; Lord Carnarvon's *Portugal and Galicia*; F. Michel, *Le Pays Basque*.)

Fuga or **Fugue** (Lat. fuga, *flight*). In Music, a composition wherein the different parts follow each other, each repeating the subject at a certain interval after the preceding part.

Fugleman or **Flugelman** (Ger. flügel, *a wing*). A non-commissioned officer, appointed to take his place in front of a regiment as a guide to the soldiers in the movements of the drill: the custom has now fallen into disuse.

Fulcra (Lat. *props*). In Botany, a term denoting the tendrils, prickles, spines, hooks, or other processes by which plants are enabled to support themselves upon other plants.

Fulcrum (Lat.). In Mechanics, the fixed point about which a lever moves. [Lever.]

Fulgora (Lat. fulgor, *an effulgence*). The generic name of certain singular insects of the order *Homoptera*, and family *Cicadariæ*, which have the forepart of the head produced in the form of a snout or large hollow receptacle; and the antennæ inserted beneath the eyes, only three-jointed, and terminated by a slender bristle. It is asserted by one naturalist (Mad. Merian), that the frontal projection emits a bright light; but others who have had opportunities of making observations on the living lantern-fly, as the larger species is called, have not witnessed the exercise of its illuminating powers, if it really possess them.

The *Fulgora lanternaria* is a native of South America; the *Fulgora candelaria* of China. There are many other species included in the Linnæan generic character, but which now form the subgenera *Otiocerus*, *Lystra*, *Cirius*, *Pœciloptera*, *Issus*, *Anotia*, *Delphax*, *Fulgora proper*, &c., in the family *Fulgoridæ*.

Fulguration (Lat. fulguratio, from fulgur, *lightning*). A term applied by the assayer to the sudden brightening of the fused globule of gold or silver, when the last film of oxide of lead or copper leaves its surface.

Fulgurites (Lat. fulgur, *lightning*). Fused or vitrified tubes formed by the passage of lightning through sand, whence has originated the designation of *fossil lightning*, which is sometimes applied to them.

Fulica (Lat.). The name of a genus of Wading birds of the family *Macrodactyli*, now restricted to those which have a strong, moderate-sized, straight, conical, and compressed bill, with a dilated naked plate at the base of the upper mandible: the toes are furnished at the sides with a scalloped membrane; the wings middle-sized. The British species, or common coot (*Fulica atra*), is well known: all its congeners approach more or less to its sooty or blue-black colour.

Fuller's Earth. An earthy, hydrated silicate of alumina, composed, when pure, of

45 per cent. of silica, 20 alumina, and 25 water. Like other soft aluminous minerals, it has the property of absorbing grease, and on that account was formerly used in large quantities by cloth manufacturers in fulling cloth, whence the name of *fuller's earth*. Its exportation was formerly forbidden under severe penalties, but the consumption has now fallen off considerably, in consequence of the substitution of soap and other substances.

Fulling (Lat. fullo, *a cloth-dresser*). The art of cleansing, scouring, and pressing stuffs, cloths, stockings, &c., to render them stronger, firmer, and closer; it is also called *milling*, because these cloths, &c. are in fact scoured by a water-mill. (Ure's *Dictionary of Arts, &c.*)

Fulminates (Lat. fulmen, *a thunderbolt*). Compounds of the fulminic acid with various bases, all more or less possessed of the property of exploding or detonating by heat or friction. The fulminates of silver and mercury (or fulminating silver and mercury) are objects of manufacturing interest; the former being used in detonating *bonbons*, and the latter more largely as a priming for the percussion caps of gunlocks.

Fulminating Mercury, Fulminate of Mercury [2 (HgO), Cy_2O_2].—This compound is prepared by dissolving 100 grains of mercury in a measured ounce and a half of nitric acid, aided by heat. This solution is to be poured, when cool, into two measured ounces of alcohol in a porcelain basin, and gently warmed: it soon effervesces and evolves ethereal vapour, and if the action is too violent, it must be quelled by cooling the vessel, or by the addition of a little cold alcohol. During this action a grey precipitate falls, which is to be immediately separated by decantation and filtration, washed with small quantities of distilled water, and carefully dried at a heat not exceeding 100°. The above quantity of mercury should yield about 120 grains of the powder. If the product is mixed with metallic mercury, it may be purified by solution in boiling water, from which it is deposited in silky acicular crystals. This dangerous compound is now in considerable demand for the manufacture of percussion caps. It is introduced, mixed with other ingredients, into the caps, closely compressed, covered with a resinous varnish, and subsequently carefully dried. When fulminating mercury is heated to about 300°, it explodes suddenly with a bright flame: it also detonates by friction or percussion (especially when placed in contact with particles of sand or glass); by the electric spark; and by contact of concentrated sulphuric and nitric acids. The gases evolved by its explosion are carbonic acid, nitrogen, and the vapour of mercury.

Fulminating Powder. A compound of three parts of nitre, two of carbonate of potash, and one of sulphur, carefully mixed and dried: about twenty grains of this powder heated upon an iron plate over a slow fire become brown and pasty; a blue flame then appears upon it, and immediately after, the whole explodes with a stunning report.

Fulminating Silver, Fulminate of Silver [2 (AgO), Cy_2O_2].—This dangerous compound is prepared as follows: 100 grains of fused and finely-powdered nitrate of silver are added to an ounce of warm alcohol in a large basin; an ounce of nitric acid is then added, and presently effervescence ensues and a powder falls: as soon as this appears white, cold water is added, and the powder collected upon a filter, washed, and carefully dried at a temperature of 100°. In collecting and handling this powder the utmost caution is requisite; it should be made in small quantities only, and not touched with anything hard, for it has exploded upon the contact of a glass rod under water. The feather of a common quill serves to collect it; and it should be kept either under water, or, if dry, in a wide-mouthed vessel covered by paper, and *not* in a stoppered or corked phial. Fulminating silver is a grey crystalline powder; it acquires a dingy hue by exposure to light; it dissolves in from 30 to 40 parts of boiling water, and as the solution cools, nearly the whole is again deposited in minute crystals. It detonates with great violence when heated, or touched by any hard substance, or when placed upon a piece of rock-crystal and touched in the slightest manner by another crystal; it also detonates upon the contact of sulphuric acid, and by the electric spark.

Fulminic Acid. An acid composed of 2 equivalents of cyanogen = 52, and 2 of oxygen = 16, corresponding therefore in ultimate composition with the *cyanic acid*. In combination with the oxide of silver and oxide of mercury, this acid constitutes fulminating silver and fulminating mercury.

Fumaramide. A white powder formed when fumaric ether is mixed with ammonia.

Fumariaceæ (Fumaria, one of the genera). A natural order of herbaceous hypogynous Exogens, inhabiting all temperate climates, and related to *Papaveraceæ* so nearly as to be incorporated with them by some writers. Their sensible properties are not of any value. A few are objects of cultivation for their beauty.

Fumaric Acid. An acid existing in the *Fumaria officinalis*, or common fumitory: it may also be produced by the action of heat on malic acid.

Fumarimide. A red powder formed on heating bimalate of ammonia.

Fumigation (Lat. fumigo, from fumus, *smoke*). The diffusion of certain vapours through the air, for the purpose of destroying contagion and infection: goods are also fumigated for the same purpose. Acid vapours have frequently been used for this purpose; there are, however, few which are effectual, and some of them, such as vinegar, only serve to cover bad smells without destroying noxious effluvia. There is no disinfectant so certain in its effects as *chlorine*; it is cheap, and easily obtained either from muriatic acid and black oxide of manganese, or from a mixture of salt, sulphuric acid, and black oxide. In inhabited rooms it requires to be cautiously used, in consequence

of its bad effects upon the respiratory organs; but even here it may be so extensively diffused as to be effective in destroying noxious matters, without serious injury to persons who breathe the atmosphere. When a room can be shut up it may be freely used, and it should be generated in saucers placed in different parts of the apartment (if a large one); and not upon the ground, but upon shelves high up in the room, for chlorine being heavier than air is thus more effectually diffused. Infected clothes and furniture may at the same time be subjected to this action. Of all common diseases, the scarlet fever is that which appears to require the most scrupulous attention to careful fumigation.

Fuming Liquors. Certain compounds which exhale visible fumes, or in common language *smoke*, when exposed to air, were so called by the old chemists. *Boyle's fuming liquor* is sulphuret of ammonium; *Cadet's fuming liquor* is an arsenical compound, now termed *oxide of kakodyle*; the *fuming liquor of Libavius* is the anhydrous bichloride of tin.

Function (Lat. functio, from fungor, *I discharge*). One quantity is said to be a *function* of another, or of several others, when its value depends upon those of the latter. Thus the area of a triangle is a function of its three sides, and $y=a+bx+cx^2$ is a function of a, b, c and x. Functions receive distinctive names according to the *nature* of the dependence above referred to. Thus the function above written is said to be an *algebraical* function of x, since y is obtainable from x by the performance of a limited and definite number of algebraical operations. Log x, sin x, a^x, on the other hand, are said to be *transcendental* functions of x, and for obvious reasons receive the distinctive names of *logarithmic*, *trigonometrical*, and *exponential* functions. The general fact that y is a function of x is usually expressed by the notation $y=\mathrm{F}(x)$, in which the *functional symbol* F merely indicates that y depends upon x in some definite manner; in other words, that the expression of y in terms of x has a definite *form*. The symbol $\mathrm{F}(y)$, used in the same investigation, would indicate a quantity which depends upon, or is derivable from y, as y depends upon, or is obtainable from x. Another expression for $\mathrm{F}(y)$, therefore, would be $\mathrm{F}[\mathrm{F}(x)]$ or, more concisely, $\mathrm{F}^2(x)$. Similarly $\mathrm{F}^m(x)$ would denote the result of m successive operations *of the same kind*, the *subject* operated upon each time being the *result* of the immediately preceding operation. Thus if

$$\mathrm{F}(x)=1+2x,$$
$$\mathrm{F}^2(x)=1+2(1+2x)=3+4x,$$
$$\mathrm{F}^3(x)=1+2(3+4x)=7+8x,$$

and so on. According to the above definition, we have obviously $\mathrm{F}^{m+n}(x)=\mathrm{F}^m[\mathrm{F}^n(x)]$, when m and n are positive integers; and an important extension at once suggests itself. If we agree that the last relation shall hold for *all* values of m and n, then $\mathrm{F}^0(x)$ would denote the subject or argument x itself, and $\mathrm{F}^{-1}(x)$ the *inverse* function of $\mathrm{F}(x)$, or that quantity from which the result x would be obtained by the operation F. Thus, in the above example, $\mathrm{F}^{-1}(x)=-\frac{1}{2}+\frac{1}{2}x$.

That branch of mathematics wherein the *forms*, rather than the *values*, of functions are investigated, is called the *calculus of functions*. The following may be taken as a simple example of the kind of questions therein examined: What function of x is that which, when multiplied by the same function of y, gives the same function of $x+y$? Representing the unknown function by F, this is equivalent to the solution of the *functional equation* $\mathrm{F}(x)\mathrm{F}(y)=\mathrm{F}(x+y)$. For an exposition of the general methods of treating such equations, see 'Calculus of Functions,' in the *Encyclopedia Metropolitana*, by Prof. de Morgan; also Babbage's *Elementary Treatise on the Calculus of Functions*; Lagrange, *Théorie des Fonctions Analytiques*; Cauchy, *Cours d'Analyse* and *Élémens du Calcul Infin.*; Peacock's *Algebra*, &c.

Functions, Laplace's. [LAPLACE'S COEFFICIENTS AND FUNCTIONS.]

Functional Determinant. [JACOBIAN.]

Fund, Sinking. It has commonly been the practice, when a portion of public debt has been created, to sustain the credit of this financial expedient, by making some provision for the gradual liquidation of the capital sum borrowed. The most obvious method is the creation of terminable annuities, the payment of interest on which is in this manner accompanied by a restitution of part of the principal. But terminable annuities have never been popular in this country, and have always been negotiated with difficulty and loss. As public securities are constantly the objects of transfer and sale, such obligations as represent a continually decreasing value are, from the inconvenience involved in determining that value, much less acceptable to investors than fixed or perpetual annuities. Since the time in which the public debt was consolidated, it has been the general practice of British financiers to grant permanent annuities, as nearly at the market rate of money as possible, and occasionally to add a small terminable annuity. For instance, in 1783 a loan of six millions was negotiated on the following terms: The advance of 100*l.* was to secure the contributor 100*l.* 3 per cent. consols, 50*l.* four per cent. consols, and 5*s.* 6*d.* annuity for 75½ years. At the estimate taken by the minister of the market value of these several securities, the terms of the loan were understood to be 57*l.* 12*s.* 6*d.* for the 100*l.* 3 per cents., 37*l.* 8*s.* 9*d.* for the 50*l.* 4 per cents., and 4*l.* 17*s.* 11¼*d.* for the capitalised value of the long annuity. It is manifest that only a very small portion of this loan was brought immediately within the contingency of repayment.

The first sinking fund established in this country for the purpose of gradually extinguishing the permanent debt, was the work of Sir Robert Walpole, and set on foot in the year 1716. By one of the clauses in an Act passed in order to put the public debt on a more satisfactory footing, it was provided that any

surplus arising from the aggregate, the South Sea and the General Yearly Funds, should be devoted to discharging the principal and interest of all debts incurred before December 25, 1716, according to a form directed by a future Act of Parliament, and should be employed for no other use or purpose whatsoever.

The accumulated surplus was funded, and the yearly interest added to the sum; the purpose being, that the sum invested should gradually absorb the public debt, and so secure its extinction by the machinery of compound interest. But very speedily the demand for supplies and the necessity for meeting deficiencies on the special taxes imposed, where future produce was over-estimated, led the administration to employ the sinking fund either as a guarantee for new loans, or to diminish its amount by making up the deficiency from its accumulations. Still, the aggregate of the fund was on many occasions devoted to the liquidation of the debt. At the commencement, however, of the war of 1739, the sinking fund had been diminished by more than three millions, and subjected to an annual charge of nearly 60,000*l.* At the end of the war in 1748 the sinking fund had contributed nine millions more to the costs of the war. In course of time the fund was to all intents and purposes exhausted.

In the year 1786, Mr. Pitt brought forward a measure for the re-establishment of the sinking fund on a 'new and secure basis.' In the formation of his scheme, Pitt sought the advice of Dr. Price, a Nonconformist minister of considerable mathematical capacity, who had pertinaciously advocated the necessity of adopting some plan for the reduction of the debt. Pitt's proposal was, that a million annually should be raised by loan or taxes, which should be vested in the hands of certain commissioners—namely, the Speaker, the Chancellor of the Exchequer, the Master of the Rolls, the Accountant General of the Court of Chancery, and the Governor and Deputy-governor of the Bank of England—in trust to purchase stock at the market price, and reinvesting the interest paid on such purchases, to accumulate the fund till its annual income should reach four millions, when the capital sum should be dealt with by parliament. It was imagined that this machinery would ultimately liquidate the debt; and the proposers of the scheme derived great satisfaction from certain arithmetical demonstrations as to the rapid growth of a capital which was brought within the beneficent operation of compound interest.

The purchases effected by the commissioners never accomplished more than the repurchase of loans in order to supply the annual million. In fact, then, the whole operation of the sinking fund was to create debt, and extinguish it; but there was also considerable loss in the process.

During the years 1793—1801, the average price at which stock was created was 57*l.* 7*s.* 6*d.*; that is, 100*l.* 3 per cents. were granted at this rate of payment. But the average market price of consols was 61*l.* 7*s.* 6*d.*; that is, the purchase of stock by the commissioners was effected at an increase of 4½ per cent. over the price at which they negotiated this annual loan, and the accumulated loss on these absurd operations amounted to 2,334,500*l.*

Between 1803 and the end of the continental war, the average price at which loans were made was 60*l.* 7*s.* 6*d.*, and the average market price of consols was 62*l.* 17*s.* 6*d.* Here the loss was 2½ per cent., and the total amount of loss in the thirteen years was 4,404,331*l.*, making the total loss consequent on the transactions of the sinking fund no less than 6,638,831*l.*

A considerable portion of this nominal fund was appropriated to meet the deficiency of supplies in the year 1813; and gradually the public became alive to the absurdity of the whole scheme. Dr. Hamilton of Aberdeen has the credit of being the first person who exposed the intrinsic futility of this and other similar sinking funds, and of having pointed out that no means can be employed for the reduction of public debts, other than by an excess of revenue over expenditure, and that when such an excess is in the hands of government, it is better to apply the proceeds at once to the extinction of a portion of the debt, than to attempt any of the machinery of a separate fund accumulating at compound interest.

See, for more information, Grellier's *History of the National Debt*; Hamilton *On the National Debt*; M'Culloch *On Taxation and the Funding System*; and Porter's *Progress of the Nation.*

Funds, Public. The name given to the public funded debt due by government.

The practice of borrowing money in order to defray a part of the war expenditure began, in this country, in the reign of William III. In the infancy of the practice it was customary to borrow upon the security of some tax, or portion of a tax, set apart as a fund for discharging the principal and interest of the sum borrowed. This discharge was, however, very rarely effected. The public exigencies still continuing, the loans were, in most cases, either continued, or the taxes were again mortgaged for fresh ones. At length the practice of borrowing for a fixed period, or, as it is commonly termed, upon *terminable* annuities, was almost entirely abandoned; and most loans were made upon *interminable* annuities, or until such time as it might be convenient for government to pay off the principal.

In the beginning of the funding system, the term *fund* meant the taxes or funds appropriated to the discharge of the principal and interest of loans; those who held government securities and sold them to others selling, of course, a corresponding claim upon some fund. But after the debt began to grow large, and the practice of borrowing upon perpetual annuities had been introduced, the meaning attached to the term *fund* was gradually changed; and instead of signifying the security upon which loans were advanced, it has, for a long time, signified the principal of the loans themselves.

Owing partly, perhaps, to the scarcity of dis-

possable capital at the time, but far more to the supposed insecurity of the revolutionary establishment, the rate of interest paid by government in the early part of the funding system was, comparatively, high. But as the country became richer, and the confidence of the public in the stability of government was increased, ministers were enabled to take measures for reducing the interest, first in 1716, and again in 1749.

During the reigns of William III. and Anne, the interest stipulated for loans was very various. But in the reign of George II. a different practice was adopted. Instead of varying the interest upon the loan according to the state of the money market at the time, the rate of interest was generally fixed at *three* or *three and a half* per cent.; the necessary variation being made in the principal funded. Thus, suppose government were anxious to borrow, and that they preferred borrowing in a 3 per cent. stock, while they could not negotiate a loan for less than 4½ per cent., they effected their object by giving the lender, in return for every 100*l.* advanced, 150*l.* 3 per cent. stock; that is, they bound the country to pay him or his assignees 4*l.* 10*s.* a year in all time to come, or otherwise to extinguish the debt by a payment of 150*l.* In consequence of the prevalence of this practice, the principal of the debt now existing amounts to nearly *two-fifths* more than the sum actually advanced by the lenders.

Some advantages are, however, derivable, or supposed to be derivable, from this system. It renders the management of the debt, and its transfer, more simple and commodious than it would have been had it consisted of a great number of funds bearing different rates of interest; and it is contended that the greater field for speculation afforded to the dealers in stocks bearing a low rate of interest has enabled government to borrow, by funding additional capitals, for a considerably less payment on account of interest than would have been necessary had no such increase of capital been made. [NATIONAL DEBT.]

Fundamental Bass. In Music, the lowest note or root of a chord. [MUSIC.]

Fundamental Triangle. [COORDINATES.]

Fundus (Lat. *a basis*). In Anatomy, the base of any cone-shaped organ: the term is usually restricted to that part of the uterus, the urinary bladder, and the gall-bladder.

Funeral (Lat. funus). [SEPULTURE, RITES OF.]

Fungi (Lat. pl. of fungus, *a mushroom*). A large class of Cryptogamic plants, of low organisation, distinguished at certain points from the seaweeds more by habit than by any general character. They agree with them in their cellular structure and the almost constant absence of vascular tissue; while they differ, according to our best authorities, in their scarcely ever being aquatic, in deriving nutriment from the substance on which they grow, and in the far lower degree of developement of the organs of impregnation. They are also nearly allied to the class of Lichens, the latter being distinguished by producing gonidia and by deriving their nourishment from the air and not from the matrix on which they grow.

The *Fungi*, observes Mr. Berkeley, may be recognised either as the creatures of corruption—i.e. springing from various bodies, whether animal or vegetable, in a more or less advanced stage of decomposition—or as parasites of living bodies, producing an injurious change. The ephemeral toadstools of the hotbed, the mushrooms of our rich pastures, the sap-balls on decaying trees, the moulds which infest our food, and even the tissues of living animals, the mildew bunt and smut of our corn-crops, with many other more or less familiar objects, are so many *Fungi*, all agreeing in the main particulars which we have indicated, and so differing from the green scum of our brooks, and the weeds of the sea, though distinguished from each other by essential differences of structure. In some, no indications of sexual differences have been found, while in others there are bodies which in all probability have an especial sexual function, though at present we are without actual proof of the fact.

Fungi are divided into two great sections, characterised by the mode in which the reproductive bodies are formed. In the one, they are simply the terminal joint or joints of the component threads or cells, altered in form from those which precede them, and at length falling off and reproducing the plant, in which case they are called *spores*. In the other they are formed from the contents of certain sacs or asci, and are usually definite in number, in which case they are called *sporidia*. Both spores and sporidia may be multicellular, and in germination give rise to as many threads of spawn as there are cells. These curious plants are ranged in six principal divisions, variously regarded as natural orders, or tribes, namely: *Hymenomycetes*, of which mushrooms and sap-balls are well-known examples; *Gasteromycetes*, represented by the puff-balls; *Coniomycetes*, of which the rust and bunt of corn afford ready instances; *Hyphomycetes*, to which belong the naked-seeded moulds; *Ascomycetes*, of which morels and insect *Sphæriæ* are examples; and *Physomycetes*, represented by the common bread mould.

The use of *Fungi* in the organised world is to check exuberant growth, to facilitate decomposition, to regulate the balance of the component elements of the atmosphere, to promote fertility and to nourish myriads of the smaller members of the animal kingdom. They occur in every part of the world where the cold is not too intense to destroy their spawn, or where there is sufficient moisture, though they abound the most in moist temperate regions. A vast number of species are known, and many of these are of great importance to man, either from their useful or their mischievous properties. The mushroom, truffle, and morel, delicacies well known at table, and the ergot, so use-

ful in obstetric practice, are illustrations of the former; the fly agaric and other poisonous species, as well as blight, mildew, rust, and brand, and the merulius and others which induce dry rot, are examples of the latter. The reader is referred, for further information, to Berkeley's *Introduction to Cryptogamic Botany*, and *Outlines of British Fungology*; Badham's *Esculent Funguses of England*; and to the illustrated works of Greville, Bulliard, Sowerby, Corda, Nees von Esenbeck, Tulasne, and Hussey.

Fungibles. In Scotch Law, such movable goods as may be estimated by number, weight, or measure, as corn, butter, ale, &c.

Fungic Acid. An acid contained in the juice of most fungi. It is said to be a mixture of citric, malic, and phosphoric acid.

Fungicola (Lat. fungus, *a mushroom*, and colo, *to inhabit*). The name of a family of Coleopterans, comprehending those which are found on mushrooms.

Fungiform, Fungilliformis (Lat.). In Botany, terms signifying *mushroom-headed*, applied to any bodies having a short thick figure, one end of which is much more dilated than another.

Fungin. The fleshy part of mushrooms purified by digestion in hot water.

Fungus (Lat.; Gr. σφόγγος). In Surgery, a term applied to the too luxuriant formation of flesh about an ulcer, or what is commonly called *proud flesh*.

Fungus Hæmatodes (Gr. αἱματώδης, *blood-red*), **Spongoid Inflammation** or **Soft Cancer.** A species of malignant tumour, called also *medullary sarcoma*.

Funicular Machine (Lat. funis, *a rope*). In Mechanics, if a body fixed to two or more ropes is sustained by powers which act by means of those ropes, the assemblage is called the *funicular machine*, or *rope machine*. If a rope is stretched horizontally between two points, its own weight alone will prevent it from becoming perfectly straight, whatever force be employed in stretching it; and a very small force applied at its middle point, at right angles to its direction, will be sufficient to overcome a very great resistance at the points to which its extremities are attached. In this manner a very small force may be made to raise a very great weight to a small height. This method of applying force is familiar to seamen, who frequently have recourse to it in bracing their sails.

Funicular Polygon. In Statics, the figure assumed by a string under the action of several pressures. The form of such a polygon being given, as well as the magnitudes and lines of action of the several impressed forces, the tensions which the several portions of the string have to sustain can be easily determined on the principle that the two tensions at each point where a pressure is applied must, jointly, hold the latter in equilibrium. When the forces are applied to smooth rings through which the rope passes, the tension at every point of the rope will be the same; and when equilibrium is established, the line of action of each pressure will bisect the angle of the funicular polygon. The funicular polygon is investigated in every good treatise on Statics.

Funiculus (Lat. dim. of funis, *a cord*). In Botany, a prolongation of the placenta in the shape of a cord, to which the ovules are attached.

Funnel of a Steamship (Lat. infundibulum; Limousin, enfounil; Bret. flounil: Wedgwood). The chimney for carrying the smoke from the furnace to a convenient height above the deck, and at the same time the channel for securing a draught for the flues. It is ordinarily of thin iron, and of considerable diameter. Modern funnels are made telescopic, so that when no great draught is necessary, they can be drawn down beyond the reach of wind or shot.

Funnel-shaped. In Botany, a term used in describing the general form of a calyx, corolla, or other organ, the tube of which is like a funnel or inverted cone.

Fur (Fr. fourrure). The coated skins of wild animals, especially of those of high northern latitudes; such as the wolf, bear, beaver, &c. The hair of fur is cleansed, and the skin is generally slightly tanned. The most valuable furs, such as ermine and sable, come chiefly from Russia. When unprepared, or merely dried, the fur skins go under the name of *peltry*.

Furfuraceous (Lat. furfur, *bran*). A term applied to certain eruptions in which the cuticle peels off in scales: also to a branlike sediment which is sometimes observed in the urine.

Furfuramide. A product of the action of ammonia on furfurol.

Furfurine. When a mixture of bran, water, and sulphuric acid is distilled, the product contains a fragrant volatile oil, which has been called *furfurol* $= C_5 H_2 O_2$. When furfurol is acted on by ammonia, it produces a yellow crystalline substance, termed *furfuramide* $= C_{15} H_6 O_3 N$, and this, when boiled in a weak solution of potash, is converted into a basic crystallisable substance, which has been called *furfurine*, and which produces with the acids a series of crystallisable salts. Furfurine is $= C_{30} H_{12} O_6 N_2$, and is a near approach to the native alkaloids. Some of its salts are bitter, and have been compared to those of quinia.

Furfurol. An oily matter formed when sugar or starch is acted upon by a mixture of sulphuric acid and peroxide of manganese.

Furies. [ERINYES; EUMENIDES.]

Furl (an old form of this word is *farthel*: furl answers to the Old Fr. fresler, *to furl*; farthel, to Old Fr. fardeler, *to truss up*: Wedgwood). In Navigation, to roll the sail up and confine it closely to the yard; the sail being gathered up by the men on the yard, the leech or edge is passed along the yard to the middle or *bunt*, where the body of the sail, the foot and clews, are collected. In this way the sails of a man-of-war are removed nearly out of view in an almost incredibly short space of time.

Furlong. An English measure of length, equal to the eighth part of a mile.

Furlough (Dutch, verlof, *leave*: Wedgwood). In Military language, the permission granted to a non-commissioned officer or soldier to absent himself for a given time from military duty.

Furnace (Lat. furnus, Ital. forno, Fr. fourneau). An apparatus wherein is placed a cavity to contain combustible matter, which in various ways is supplied with air to facilitate its combustion. The two classes into which furnaces are divided are air or wind furnaces, and blast furnaces. In the former the air is conducted through the fire by the draught of a funnel or chimney which communicates with it; in the latter, the action of bellows or some other pneumatic apparatus supplies the air. The word *furnace* has generally, however, a more circumscribed application; being applied usually to an apparatus for the fusion of metals, or to that used in a chemical laboratory. [Foundry.]

Furniture (the Italian, French, and English forms of this word point to the Latin furnus, *an oven*: Wedgwood, *English Etymology*). In Architecture, the visible brasswork of locks, knobs to doors, window-shutters, and the like.

Furniture. In Printing, the materials used to extend pages of type to their proper length; also to separate them, when imposed, to a just distance from each other, so that when the sheet is printed and folded the margin shall be regular and uniform. [Imposing.] Furniture consists of pieces of oak wood planed up to specific thicknesses, and to about half an inch high; sidesticks and footsticks, which are placed at the outside of the pages, and made thinner at one end than the other, to allow the quoin to secure them more effectually; and quoins or wedges, usually made of beech wood, with which the pages are wedged up in a chase. Furniture smaller than two-line great primer is called *reglet*.

Furring. In Architecture, the small slips nailed on joists or rafters, where some parts of them are lower than others, or where the surface is not regular, so as to bring the boarding which they are intended to receive to the same plane.

Furunculus (Lat. from fur, *a thief*). A boil, or inflammation occurring in the cellular membrane beneath the skin, terminating in the formation of pus. A boil has a central core, and the pus forms in a cavity circumscribed by indurated cellular tissue. When many boils appear at once, or follow each other in rapid succession, the constitution often suffers severely, and it is advisable to pay attention to the state of the secretions, and to support the strength by tonics and good diet. In the young, or in cases in which only one boil appears, no treatment is required; but in the old who suffer from a succession of boils, much care is requisite. Eruptions of the skin characterised by the formation of small furunculi have rather indiscriminately been termed *furuncular eruptions*. [Carbuncle.]

Furze. The *Ulex europæus* of botanists, a prickly bush, found abundantly in exposed heaths in England and the more southern countries of Europe, from which it is by some supposed to have been introduced; a conjecture rendered probable by its not being able to bear the more rigorous of our winters. Its preference for sterile soil has caused it to be extensively used for fences in such land, as a cover for game and a shelter for young plantations. Its young and tender shoots are browsed upon by sheep and cattle. On some inferior soils it is cultivated with profit for these shoots; and even the older stems, when crushed, are good and wholesome fodder.

Fuscin (Lat. fuscus, *tawny*). A brown colouring matter obtained from empyreumatic oils.

Fuse or **Fuze.** In Artillery, a case of wood or metal, containing an arrangement for igniting the bursting charge in a shell. For smooth-bored guns the fuse is ignited by the gas from the powder passing round the shell; but for rifled guns by a percussion arrangement, set in action by the shock of the discharge. The fuse fits into the fuse-hole of the shell, which is sometimes furnished with a socket or bouche.

Fusee. In Watchwork, that part of the machinery about which the chain is wound, and which is immediately acted upon by the main-spring. The use of the fusee is to equalise the action of the spring. In proportion as the spring becomes unwound, its effort continually relaxes; so that

if the first wheel were attached to the barrel, as is often the case in common watches, the inequality of the impelling power would produce a corresponding inequality in the rate of going. In order to correct this, one end of the chain is attached to and wound round the barrel in which the main-spring is contained; while the other end is coiled about the fusee, which has a conical shape, and is fixed on the axis of the first wheel. The principle generally adopted for determining the figure of the fusee is, that its radius, at any point to which the chain is a tangent, should be inversely as the tension of the chain in that position. Within certain limits this is nearly true; and if we assume with Hooke that the force of a spring is proportional to the distance to which it is drawn from the position of rest, and also lay aside all consideration of the length of the chain wrapt about the fusee, it would be easy to show that the fusee should be the solid generated by the revolution of the equilateral hyperbola about its asymptote. This conclusion is, however, by no means correct; but though the subject has been treated by several eminent mathematicians, very little practical advantage has been derived from their theoretical investigations. In fact, a moderate approximation to the true figure (whatever that may be) is all that can be attained in practice, and all that is necessary.

Fusel Oil. [FOUSEL OIL.]

Fusible Calculus. That species of urinary calculus which consists of a mixture of ammonio-magnesian phosphate and phosphate of lime, and which is characterised by the facility with which it enters into fusion before the blowpipe.

Fusible Metal. An alloy of eight parts of bismuth, five of lead, and three of tin. It liquefies at a temperature below 212°. The addition of about one part of mercury or of cadmium renders it still more fusible.

Fusible Salt of Urine. A name by which the old chemists designated the *ammonio-phosphate of soda*, obtained by the evaporation of urine.

Fusiform (Lat. fusus, *a spindle*). Spindle-shaped; thickest at the middle and tapering towards the ends.

Fusil (Fr.; Ital. focile, *a fire steel for a tinder-box*). A term first met with in the seventeenth century, and applied to a light musket nearly similar to a carbine, with a flint lock. The fusil was originally used by light companies; and in the British army it has given its name to several regiments called the *fusiliers*.

FUSIL (Fr. fusée). In Heraldry, a bearing of a rhomboidal figure more slender than the lozenge; its upper and lower angles being more acute than the two middle ones.

Fusinae (Lat. fusus, *a spindle*). In Conchology, a term used for spindle shells, analogous in shape to the genus FUSUS [which see].

Fusion (Lat. fusio, *a pouring forth*). *Aqueous* or *watery* fusion is the liquefaction by heat of salts containing water of crystallisation. *Igneous* fusion is liquefaction by heat of bodies which contain no water.

Fustian (Fr. futaine, Ital. fustagno). A thick twilled cotton, of which velveteen, corduroy, and thickset are varieties. [VELVET.] Fustian is generally dyed of a deep olive or lead colour.

Fustic. A yellow dye stuff. Two kinds of fustic are occasionally used by dyers. *Old fustic* is the wood of a large tree, the *Maclura tinctoria*, which grows abundantly in many parts of the West Indies and America; it gives a dingy yellow dye, chiefly useful in the production of compound colours. *Young fustic* is the *Rhus Cotinus*, or Venice Sumach, a shrub growing in Italy and the South of France; it gives a greenish-yellow dye, and is also used as an accessory material.

Fustin. The yellow colouring matter of fustic.

Futtock Plates. Flat iron bars or plates, receiving at one end the lower dead-eye of the topmast rigging, and at the other the futtock shroud.

Futtocks. In Nautical language, the timbers between the floor timbers and the top timbers.

Future Tense. In Grammar, that inflexion of the verb which expresses future time. In all Aryan languages, this inflexion is produced by a combination of the auxiliary verbs, *to have* or *to be*. Thus the Greek *τύψω*, *τυπ-σ-ω*, exhibits the root AS *to be*, in combination with the root *τυπ*, *to strike*: the Latin *amabo* in the same way exhibits the root BHU, *to be*. Thus again the French *parlerai* is made up of the infinitive mood parler, and the present tense of avoir, *to have*: the Provençal forms *dir vos ai*, *dir vos em*, show these elements in their genuine and uncompounded form.

END OF THE FIRST VOLUME.

LONDON
PRINTED BY SPOTTISWOODE AND CO.
NEW-STREET SQUARE